SCIENTIFIC AMERICAN SUPPLEMENT. No 1809

Entered at the Post Office of New York, N. Y., as Second Class Matter.
Copyright, 1910, by Munn & Co., Inc.
Published weekly by Munn & Co., Inc., at 361 Broadway, New York.
Charles Allen Munn, President, 361 Broadway, New York.
Frederick Converse Beach, Sec'y and Treas., 361 Broadway, New York.

Scientific American, established 1845.
Scientific American Supplement, Vol. LXX., No. 1809.

NEW YORK, SEPTEMBER 3, 1910.

Scientific American Supplement, $5 a year.
Scientific American and Supplement, $7 a year.

THE MANUFACTURE OF QUARTZ GOODS.

By Our Berlin Correspondent.

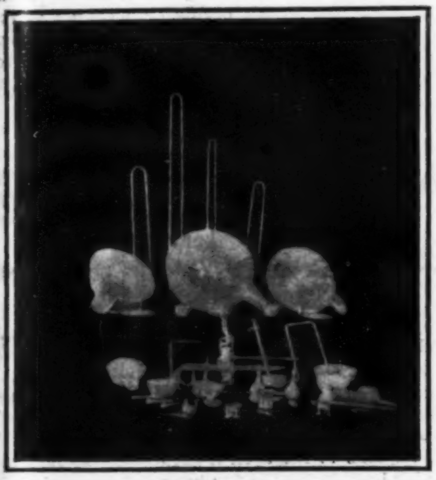
The quartz goods recently placed upon the market by Continental and British manufacturers consist of a glass-like mass melted in the electric furnace and endowed with specially valuable properties. On account of the manifold uses this material can be put to, some particulars of early experiments and present manufacturing processes will be found interesting.

It is generally known that quartz exists in nature in the crystalline and amorphous conditions, the former variety being known as rock crystal and quartz sand, whereas the latter is represented by a number of opals. On heating a piece of rock crystal in an open flame it is made to crack, and when the numerous fragments thus obtained are melted in the electric furnace a compact amorphous mass is produced which has become absolutely insensitive to temperature influences, and in fact shows physical properties entirely different from those of rock crystal.

The cracking of rock crystal is explained by the external layers being heated far more rapidly than the interior ones, especially in the case of intense heating. Being thus expanded more than the interior of the mass, they set up stresses resulting in its rupture. Melted amorphous quartz, on the other hand, only shows a much smaller expansion, in fact, only one-sixth of that of ordinary glass, on being heated in a flame, and accordingly does not give rise to any stress capable of destroying it.

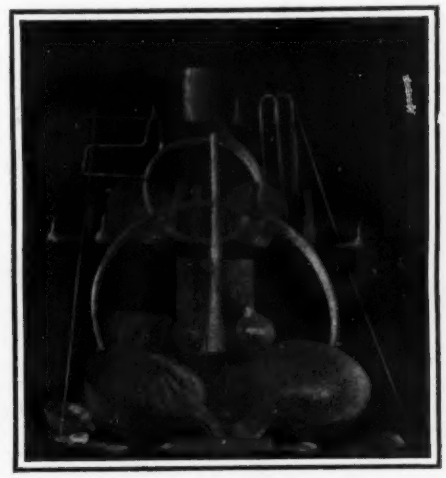
Though this behavior of quartz had been known for many years, no suitable melting process for converting the crystalline into amorphous material is so far available. It is true that at the fifth International Congress of Applied Chemistry, a paper was presented by Dr. Heraeus of Hanau, describing the use of the oxyhydrogen blowpipe for the working of quartz. Though the articles submitted by the author elicited general admiration for the skill of the workman, the process was necessarily very slow, and too expensive to lend itself to any application on a commercial scale, the more so as the sizes were rather limited.

In 1902 Dr. Hutton published a description of his experiments on the fusing of silica by means of electric arc and resistance furnaces. Since then a large number of experimenters have been engaged in the same line of work. While fused silica or quartz is endowed with properties that make it an almost ideal material for certain purposes, especially in the chemical in-



SPECIMENS OF QUARTZ ARTICLES.

VARIOUS QUARTZ ARTICLES.



SAMPLES OF QUARTZ WARE.

THE MANUFACTURE OF QUARTZ GOODS.

dustry, it is one of the most refractory of substances, requiring a temperature of about 2,000 deg. C. (3,630 deg. F.) for getting into a working condition. However, the main difficulty is not so much due to the necessity of producing such a very high temperature (though this is somewhat serious in the case of large masses) as to the fact that at a temperature of 2,000 deg. C. there are practically no materials suitable for the containing vessels in which the quartz is to be melted, and that nearly all materials react with it at that temperature. The iridium tubes used by Dr. Heraeus, which are almost the only known material withstanding the requisite temperature which does not attack silica, cannot obviously be employed for working on a large scale on account of the high price the metallic element commands.

In 1903 Dr. J. Frank Bottomley commenced in a small experimental works erected at Wallsend, near Newcastle-on-Tyne, a series of interesting investigations with the object of developing a method suitable for the manufacture of large size silica apparatus. In spite of the many difficulties encountered in this connection, the experiments after three years were sufficently advanced to commence working on a commercial basis.

As it was intended to obtain a relatively cheap product, a raw material less expensive than rock crystal had to be looked for, and a very pure form of silver sand containing over 99½ per cent of silica was used.

Electric arcs as well as various forms of resistance furnaces were used in connection with these experiments, but the arc method was found not to be practical on account of the difficulty of regulating the temperature, and the risk of the material being contaminated by fragments expelled from the electrodes. Far more satisfactory results were obtained with resistance furnaces using carbon or graphite as resistance material.

Now the limits of temperature between which these furnaces can be worked are exceedingly narrow, because the temperature at which quartz reacts with carbon to form carborundum is very close to the temperature required for working the silica. Another difficulty is due to the silica volatilizing readily at temperatures a little above the melting point. The difficulty of finding a material sufficiently refractory to serve as the containing vessel, while being chemically inactive in regard to silica, was overcome by allowing the sand itself to form its own containing vessel, which method shows the additional advantage of providing an excellent heat insulating material for the lagging of the furnace. As the surface of the silica farthest from the heating resistance is not thoroughly fused, it should be subjected wherever necessary to a subsequent glazing process. As silica, even at very high temperatures, never becomes really fluid, but attains a consistency like that of tar, it cannot be made transparent. However, in this plastic condition the material is capable of being worked into shape either by blowing or by mechanical pressure. It is, for instance, quite possible to draw a length 60 feet or more of ¾-inch tubing. At the works of the Thermal Syndicate, Wallsend, where the Bottomley process is used, fusions of over 70 pounds can be made, and worked into shape, and it is hoped to increase this considerably.

After being molded, the silica passes through a series of operations such as cutting and grinding. On account of the great hardness of the material the usual methods employed in connection with glass are not suitable, and special means had to be devised. The small laboratory ware, such as basins, crucibles, boats, etc., also undergo a special glazing treatment.

Another process for the working of silica which has been made known lately is that of the Deutsche Quartz-Gesellschaft, Limited, at Beuel, near Bonn. In this process the Voelker-Borcher electric furnace is used to get the material at white heat into a plastic condition. Since the consistency of silica thus does not allow of its being cast or compressed in molds, as in connection with glass manufacture, special methods had to be designed. When a pill of moist paper is introduced into the hollow plastic block raised to white heat, the water undergoes sudden evaporation, and the hot fused silica is violently thrown by the expanding water vapor into the surrounding mold. The same process also lends itself for the drawing of quartz tubes as well as for the shaping of all kinds of bowls, crucibles, bottles, plates, cups, etc.

The most valuable feature of these goods is their remarkable insensitiveness to temperature changes, which even allows iron or platinum to be sealed into quartz crucibles without the latter losing their shape. Another valuable property is the insulating power of quartz, which, though decreasing somewhat with rising temperatures, is even at the temperature of electrical furnaces quite sufficient to make the quartz an electric insulator. This feature is the more welcome, as most oxides used in industry will become conductive to electricity at high temperatures. Quartz is therefore an extremely suitable material for making electric radiators. As quartz tubes are fairly pervious to heat rays, they can, in fact, be used also for the transmission of heat. For a similar reason quartz plates are extremely practical as refractory protective mantles, undergoing a relatively immaterial heating even on being radiated upon intensely.

The same property makes silica a very valuable material for the construction of fireplaces, drying ovens, etc. Whereas the iron sleeve of an ordinary iron stove gives off its heat only to a small extent by conduction, and by far the greater part by radiation to the surroundings, conditions are much more advantageous when quartz is used as oven material. The heat of the fireplace, in fact, then radiates directly through the quartz walls, heating up the room, while the quartz sleeve itself is not heated up sufficiently to set on fire any combustible objects coming into contact with it.

The electrically heated drying oven constructed on this principle by the German company above mentioned has given surprising results, the surplus cost of the quartz being more than compensated by the increase in efficiency and safety.

MOTHER-OF-PEARL.

A CURIOUS INDUSTRY OF THE SOCIETY ISLANDS

SHELL DIVERS AND VALUE AND USES OF THE PRODUCT.

Consul Julius D. Dreher, of Tahiti, furnishes the following information concerning the mother-of-pearl industry in the South Seas, especially that of the Society Islands:

Mother-of-pearl shells are found on the Pacific coasts of North and South America, in the islands of the Pacific Ocean, in the Philippines, on the coasts of Australia and in the adjacent islands, on the coasts of India and in the islands of the East Indian Archipelago, in the Persian Gulf, in the Red Sea, and in Zanzibar. These shells, which form an important article of commerce, are largely used for making buttons and the handles of fruit, dessert, and pocket knives; for inlaying furniture, musical instruments, Japanese and Chinese lacquer work, European lacquer, and papier-mâché work; in manufacturing a variety of small and fancy articles. In Russia mother-of-pearl is used for ornamenting church vestments, and in Austria for making beautiful jewelry; in Italy high-relief cameos are carved on mother-of-pearl shells, and in Turkey allegorical and ornamental designs are engraved on large polished shells which are known as Jerusalem shells. Natives of a number of tropical islands make ornaments of the shells and in the south Pacific they use mother-of-pearl fishhooks, which are so bright that no bait or other lure is necessary.

FORMATION OF THE TUAMOTU ARCHIPELAGO.

In the colony of Tahiti mother-of-pearl shells are found chiefly in the Tuamotu (or Low) Archipelago, which embraces the Tuamotu (or Paumotu) and the Gambier Islands, and extends in a southeasterly and northwesterly direction for 1,000 miles, the greatest width of this belt of islands being 300 miles. With only a few exceptions the 82 islands composing this archipelago are now low-lying atolls of coral formation, narrow strips of land forming a chain of islands and islets, in most cases separated by passes of water and stretches of partially submerged coral reefs. These islands and coral reefs together inclose lagoons, some of which are of considerable extent, the largest, that of Rangiroa, being 40 miles long and 20 miles wide. At nineteen of these islands are passes which enable schooners of ordinary size to enter the lagoons. The total land area of the eighty-two islands is 345 square miles and the population is a little more than 5,000, which is scattered over about half the number of islands, the rest not being permanently inhabited. The cocoanut palm flourishes throughout the archipelago, and other trees of small size and a good deal of shrubbery are found on most of the islands. The soil being unfit for cultivation, the people for the most part live on cocoanuts, fish, and bread made of American flour, except during the diving season, when other articles of food, including canned meats, are consumed. The natives have an ingenious method of catching fish in June, July, and August by building narrow passes with coral stone pens, which the fish enter through long narrow openings.

WHERE THE SHELLS ARE PRODUCED.

While shells are produced in all the islands, they are found of good quality and in paying quantities in fewer than one-fourth of the lagoons. The most productive of the Tuamotu Islands are Mikueru, Takume, Takaroa, and Takapoto, of the first rank; Marokau and Ravehere, of the second rank, and Hao, Motutunga, Manihi, and Raroia, of the third rank. Of the Gambier Islands, Mangareva, Akamaru, and Akena produce shells which are large and heavy, but their quality is not very good. The time for the opening and closing of the diving season, which usually lasts from the first of May to the first of November, and the names of the islands open for the season are published months in advance in the Official Journal of Tahiti, together with the regulations to be observed and the penalties for their violation. The large islands are divided into three sections, only one of which is open during a season, and the small lagoons also are open only once every three years. This year there will be open thirteen sections and lagoons, some of the latter being insignificant. Before the opening of the season Papeete merchants send to the islands schooners laden with supplies which are stored in portable houses built chiefly of corrugated iron. The shells in the lagoons are regarded as the property of any natives of the colony who will dive for them, but as almost all the good divers live in the Tuamotus they reap the profits of the diving season. The schooners transport the divers and their families from other islands to those open for taking the shells. These people carry with them pigs or hogs, bread, and other things to give to the islanders among whom they are to live for some months. The merchants advance supplies to the divers and also furnish them lumber to make their boats, each of which is constructed of three boards of California redwood and provided with an outrigger to steady it in the lagoon. For an anchor a piece of lead fastened to a small rope is used. If an open island fails to yield satisfactorily, the houses, supplies, and people are removed to other islands where better results may be obtained. During the season a favorite island presents a lively scene, with its encampment of as many as 1,000 men, women, and children.

DIVING FOR SHELLS.

The hours for diving are from 9 to 2. The diver paddles his canoe out into the lagoon and anchors it, and, if he happens to hit upon a good place, he may not move his boat during the five hours. A basket to hold the shells is let down by a rope tied to the boat. On the end of another small rope, also tied to the canoe, is a piece of lead weighing from 15 to 20 pounds. The diver, who wears only a narrow loin cloth, places one foot upon the lead, with the rope between his toes, stretches the rope with one hand held against his chest, utters several loud yells to empty his lungs, refills them quickly with pure air, and descends rapidly, feet foremost, to the bottom of the lagoon. His goggles exclude the water and enable him to see from 12 to 15 feet. He tears the shells from their support, usually a piece of dead coral, to which they are firmly fastened. He may fill the basket with 30 or 35 pounds of shells at once, and he may have to dive several times to fill it. When his time is up the diver ascends by means of the rope and immediately wipes himself dry with a towel. He rests and warms himself in the sun from 10 to 15 minutes before going down again. A good diver will go down from 20 to 25 times in the five diving hours. As the basket is filled it is drawn up and the shells are emptied into the boat. The man's wife or some other member of his family, who accompanies him in the canoe, occupies herself by opening the shells, putting the contents in a bucket and washing the shells, from which she also removes the barbs. Having finished the diving for the day, the man assists the woman in her work. The matter in the bucket is crushed in the hands and then thrown overboard. A part of the mollusk is good to eat when thoroughly boiled, then fried in canned butter, and served with a wine or white sauce, but the natives care little for it, especially as they have plenty of money during the season to buy other food. While he is gathering the shells the diver often comes up to get a harpoon to spear fine fish, which he is easily able to do, as the fish seem to pay no attention to his presence and movements in the water. In this way he helps out his scanty larder. After a good breakfast the diver eats very little until 6 o'clock, when he is ready for a substantial meal and sound sleep.

THE WORLD'S BEST DIVERS.

This colony has the best divers in the world. They dive all the way from 6 to 120 feet (rarely more) in their work and remain under water a minute and a

half for the average man, two or two and one-half minutes for a good diver, and three minutes for a few exceptional experts. Among the pearl divers of Ceylon the highest record is 110 seconds. Diving for shells is hard and wearing work. Like many other industries, it exacts its toll of human life. At the beginning of each season the nose and ears of the diver bleed when he comes up out of the water, and sometimes he vomits blood. His eyes become affected and paralysis of the arms and legs is not uncommon. He is at his best between the ages of 20 and 25; after 30 he begins to decline and is able to dive less and less as he grows older. Boys who wish to become divers for shells begin to practise soon after entering their teens. Between 15 and 17, when they have not yet learned the limit of their capacity, they occasionally stay down a little too long and give out before the boat is reached by the rope. It is said by those well informed that half a dozen men usually lose their lives in this manner during each season.

More than 30 diving machines were imported from the United States and used during the seasons of 1903 and 1904, but the authorities feared that the supply of shells might be depleted and the use of machines was interdicted before the merchants realized any net profits from their use. Two years ago 10 machines were sent back to San Francisco, 10 others are stored in an old cotton-gin house in Papeete, while the rest are in different places in Tahiti. A number of efforts have been made to increase the quantity of shells by cultivation, just as oyster banks are set out in the United States, but these efforts have been unsuccessful.

THE PEARL TRADE—PAY OF THE DIVERS.

The finding of pearls in the mollusks adds a singular fascination to the hard work of the toilers in the deep. Occasionally the rare black pearl is found, but nearly all the pearls are of the usual color, and not many of them are of any considerable size. The pearl buyers show no little activity in going the round of the islands to make purchases, but no statistics are kept, and the dealers are reticent as to the extent of their business. It is estimated that about $20,000 is paid for the pearls found in a season. As the pearls, as well as the shells, are the perquisites of the divers, the best of the men are able to make from 5,000 to 7,000 francs ($965 to $1,351) during a season; but the average diver probably realizes about 3,000 francs ($579), chiefly from the sale of shells to the agents of Papeete merchants who are on the ground for that purpose.

CHARACTER OF SHELLS PRODUCED.

Mother-of-pearl shells are the calcareous covering of the bivalve pearl oyster Meleagrina margaritifera. This mollusk thrives best in lagoons where it is protected from heavy seas and shifting sand. It is necessary for it to have some sort of support, such as dead coral, stones, or wood, to which it may attach its shell by means of its byssus.

The shells produced in this colony are of the black-edged variety and are the best of the kind found in the world. As they are all brought to Tahiti for exportation they are known in the markets of the world as Tahiti black-edged shells. The dark edge is from a half to three-fourths of an inch in width. The rest of the inside is of a bright pearly appearance, with iridescent hues around a wide border including the dark edge, the play of these shifting rainbow colors being extremely beautiful as the shell is moved in the light. Many fine large specimens of these shells may be seen in Tahiti homes, where they serve as ornaments. The smaller ones would make attractive dessert plates. The outside of the shells is quite rough, but it also takes a fine polish and then reflects iridescent hues as effectively as the bright inside does. The largest shells come from the Gambier Islands, which are only four in number, not counting insignificant islets. A French scientist gives an account of a pair of these shells that measured 10 4/5 inches in width and 13 inches in length, and weighed 12 pounds; but shells of that size are extremely rare. I have seen a pair only half an inch less in width and length, but they are not heavy shells. The divers are forbidden to take and merchants to export shells that measure less than 4 inches wide in the clear; that is, not including the outer jagged edge which projects beyond the pearly part. Most of the shells exported average about 6 inches in width and weigh from 60 to 80 pounds to the 100 single shells, though of course many are considerably wider and heavier.

EXPORTS OF SHELLS.

Local schooners bring the shells in bags or in bulk to Papeete, the commercial center of the colony. The work of assorting the shells according to size and quality is done chiefly by native women, who also help men to pack them in strong boxes with a capacity of about 225 pounds each. Nearly all Tahiti shells are shipped by way of New Zealand to London, which is the world's greatest market for this article of commerce. A customs duty of $7.72 a ton is collected on shells when brought to Tahiti and an additional duty of $11.58 a ton when they are exported.

Among the products exported from the colony mother-of-pearl shells rank second in value, copra holding first and vanilla third place. The quantity of shells exported varies considerably from year to year, the average being about 475 tons a year, which is rather more than the demand for such shells at good prices. In 1908 the exports amounted to 635 tons, valued here at $152,468 (a low valuation); last year the amount was 593 tons. A large exportation always results in lower prices, but the price of Tahiti black-edged shells has been depressed for some years because articles manufactured of such shells are not fashionable, which affords a good illustration of the manner in which fashion affects the business of even the remote islands of the South Seas. In 1902 the best Tahiti shells sold for $1,200 a long ton in London; at the auction sales in that city early in the current year the best brought $750 a ton. At the same time the best white shells from the Straits of Macassar sold for $1,400; the best Australian, $1,300; the best Manila, $1,050, and the best East Indian, $900 a ton. Shells are generally assorted into six grades. The first grade does not embrace any large proportion of the shells, probably not one-sixth, but the second grade sells for very nearly as much as the first. Then there are defective shells, wormy pickings, and broken pieces, all of which are sold at the London auctions, the lowest grades at about half the price commanded by the first grade. No statistics are available to show the world's production of mother-of-pearl shells, but it runs well up into thousands of tons.

HOW THE AMERICAN IMPORTS OF SHELLS FELL OFF.

For a long time the United States received annually a large proportion of the exports of shells from Tahiti. In 1890 the proportion was 643 out of a total exportation of 656 tons; in 1900, 86 out of a total of 443 tons, the decrease continuing from that year until zero was reached in 1908. Last year, however, the United States received 31.5 tons out of a total exportation of 593 tons. During the years of the large shipments to San Francisco the merchants of that city employed an expert to grade the shells, and lists of the quantities of the several grades on hand were sent to buyers in eastern cities to give them an opportunity to put in bids for the auction sales. It is said that New York dealers now buy their supplies in London. Freight on shells from Papeete to San Francisco is $8 a metric ton, gross, and to London $21.36 a long ton, gross; fully 20 per cent of the weight paid for is for boxes.

It requires from five to nine months to receive returns on shipments to London, and as Papeete merchants would prefer, other things being equal, to ship where they could realize on their shipments in the shortest time possible, it seems that American consumers of Tahiti shells should be able to make satisfactory arrangements to receive their supplies of these shells through San Francisco instead of by the roundabout way of London.

THE SURFACE DIMENSIONS OF PAPER.

P. KLEMM in the Wochenbl. Papierfab. discusses the surface dimensions of paper and their variations. Paper undergoes expansion when moistened or stored in a moist atmosphere and shrinks again on drying. This property constitutes a serious source of inconvenience in many uses of paper, leading to "cockles," wavy edges, and creases. Different types of paper show considerable differences in the amount of expansion on damping and in the distribution of the extension between the machine and cross directions of the sheet. It is the aim of the paper maker to keep the superficial variability of the paper as low as possible consistent with the production of the specific characters of the type of paper, and to contrive that the expansion shall be as nearly as possible equal in both directions. Klemm has instituted a series of determinations of the expansibility of various types of paper: A piece 200 millimeters square is cut by means of a template from the sheet of paper. This is floated on the surface of water until it is saturated and the air expelled; it is then totally immersed. The excess of moisture is next removed by blotting paper and the dimensions of the sheet are measured, the operation being repeated until no further expansion is recorded. The paper is then allowed to dry with full liberty to contract freely, in an atmosphere containing 65 per cent of saturation-humidity, until constant dimensions are attained. Lastly it is dried at 100 deg. C., and again measured. These observations give, for the machine and cross directions of the sheet respectively, the percentage elongation on damping, the percentage contraction (from the original dimensions) on re-drying in the air and on re-drying at 100 deg. C., the total range of variation and the ratio of variation between the two main directions of the sheet. The last-mentioned ratio is of considerable importance, especially in the case of lithographic papers which have to show accurate register of the different colors. It rarely approximates to 1 : 1 in the case of ordinary machine-made papers, but a ratio of 2 : 1 is fairly satisfactory for multicolor work. The total range of variation between saturated and re-dried (air dry) dimensions rarely falls below 0.5 per cent for the machine direction and 1 per cent for the cross direction, and these values may be regarded as satisfactory standards for lithographic work.

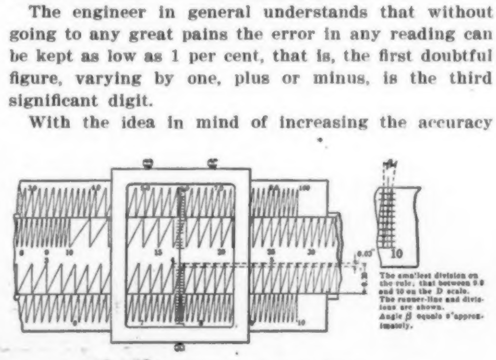
A PRECISION SLIDE RULE.*

By A. N. LURIE.

THE Mannheim slide rule, as arranged fifty or sixty years ago by Col. Mannheim of the Austrian Engineer Corps, has served the engineer and the scientist for half a century, as a valuable instrument.

The engineer in general understands that without going to any great pains the error in any reading can be kept as low as 1 per cent, that is, the first doubtful figure, varying by one, plus or minus, is the third significant digit.

With the idea in mind of increasing the accuracy



A PRECISION SLIDE RULE.

of the slide rule, and at the same time of avoiding an involved instrument, I stumbled upon a device which I believe will make a more accurate and desirable tool. The accompanying drawing shows a full size layout of the middle portion of the scales. The fundamental principle is not a new one by any means. In this slide rule, it consists substantially of lengthening the graduations several hundred per cent, without increasing the length of the rule. A perpendicular to the longitudinal center line is erected at each major division, a major division being, for example, the distance between 5.1 and 5.2. A series of perpendiculars, all of the same length, is formed and lines are drawn from that extremity of each perpendicular farthest from the slide to the foot of the next one. These lines, the hypotenuses of a series of right triangles whose bases are the logarithmic divisions, and whose altitudes a given distance, now become the scale proper. Horizontal graduations on the runner-glass, which are intersected at right angles by the hair line, divide the perpendiculars, and, of course at the same time the hypotenuses, into ten equal divisions.

In the rule herein the distance between indices is 25 centimeters (9.84 inches), known commercially as the "ten-inch rule," the increase in scale length in the lower scales will be a little over 200 per cent, while in the upper scales it will probably reach as much as 300 per cent or more. The length of the perpendiculars is 0.3 inch, making each division on the runner glass 0.03 inch, or about 1/32. This makes the rule easy to read. The smallest angle which occurs between the hair line and any hypotenuse is that on the lower scales, between the divisions 9.9 and 10. This angle is 9 deg. The runner glass is very thin and close to the scales, so as to avoid parallax as much as possible. It is adjusted by three small set screws, two above and one below. The operation of this rule and the Mannheim are identical.

The accuracy is increased from one in a hundred to one in a thousand. This instrument is easier to construct than the Mannheim, as it reduces the number of lines in the scale from 1,284 to 820, or a reduction of 36.1 per cent. It is a simpler and at the same time more accurate instrument.

* Condensed from The Technograph, as reprinted in The Engineering and Mining Journal.

SOUTHEASTERN ALASKA.

J. W. BAGLEY, assisted by C. E. Giffin, is continuing the detailed topographic survey of the Eagle River district begun last year. It is proposed to complete the survey of the gold-bearing belt which lies between Juneau and Berners Bay. The resulting map will be published on a scale of 1 mile to the inch, with 50-foot contours, and will be of great value to the prospectors and mine operators in this belt. It will also be used as a base map for the detailed study of the geology and mineral resources. Adolph Knopf, who is now on the way to the field, will undertake to complete the geologic work in this belt. He will also devote some weeks to a study of the Chichagof gold-bearing district, north of Sitka, and will continue general reconnaissance work in Southeastern Alaska.

HOISTING BOATS ELECTRICALLY.

THE ANDERTON ELECTRIC DRIVEN CANAL BOAT ELEVATOR.

BY FRANK C. PERKINS.

THE River Weaver in Cheshire, England, is a stream navigable for a distance of 21 miles by steam barges of 300 tons, between Weston Point, near Runcorn, on the Manchester Ship Canal, and Winsford. It serves to connect Northwich, where the Cheshire Chemical and Salt Industries are located, with the sea. About four decades ago, in order to provide facilities for intercommunication between the River Weaver at Anderton and the Trent and Mersey Canal, the Anderton canal boat elevator was constructed. Hydraulic power was first utilized for a number of years for raising and lowering the barges instead of employing a series of locks, which would have meant a large loss of water by the canal, and the necessity of occupying a great amount of space.

The first electrification of the Anderton boat-lift was carried out in 1902, when the steam boilers and engines were replaced by electric power for driving the hydraulic pumps, and this was found to be somewhat cheaper than steam on account of the intermittent load. A short time ago hydraulic power was eliminated entirely and electric power utilized exclusively, the cost being considerably less with direct electric motor driven machinery than with electric driven hydraulic pumps. It is stated that the daily consumption of electricity by the Anderton canal boat elevator averaged about 118 kilowatt hours per day, using electric driven hydraulic pumps, while the current consumption was reduced to about one-half this amount for doing exactly the same work by the direct application of electric power with electric motors.

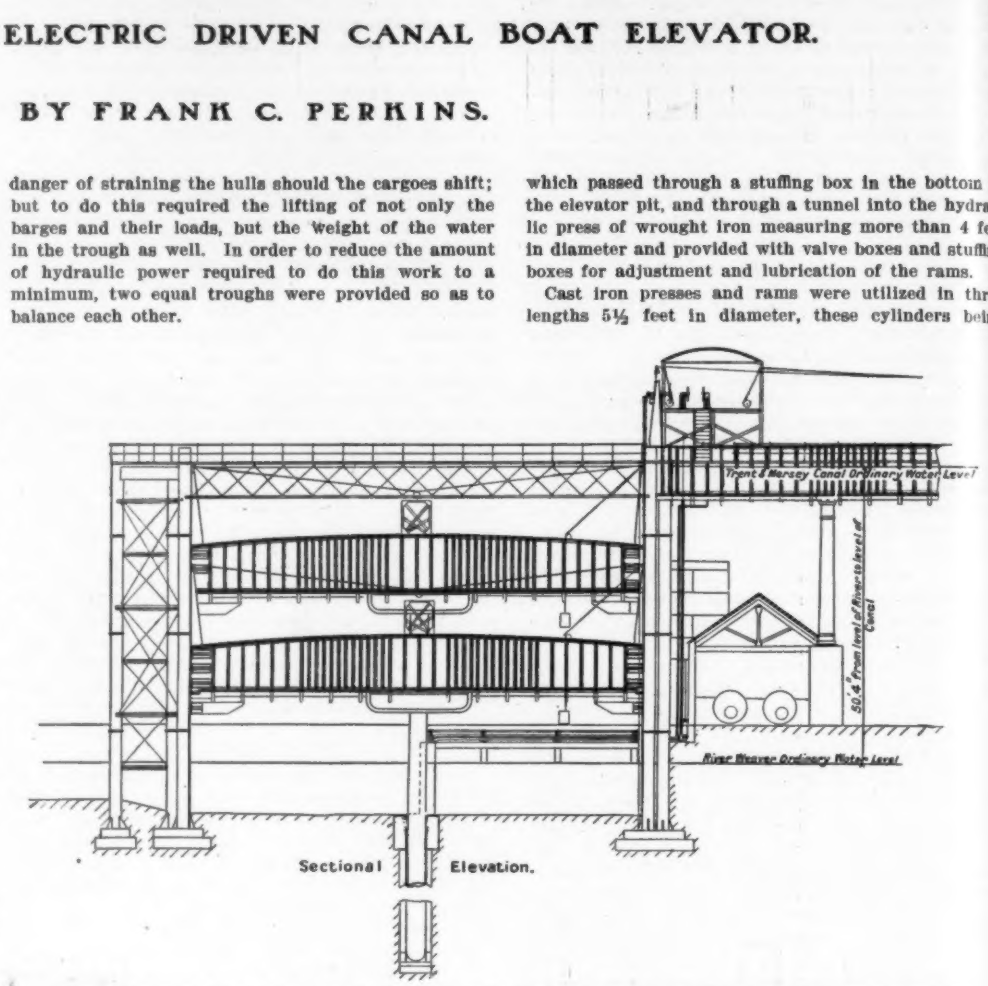
The electric power required for operating the elevator is said to be only that necessary to overcome the friction of the pulleys on their bearings and other sources and that, although the weight moved is more than a million pounds, the actual power required is only about half a kilowatt hour for the single stroke of 50 feet, the energy consumed being about 8 horsepower for a period of from 5 to 6 minutes. The rate paid for electric current varies from 2 to 4 cents per kilowatt hour. It is maintained that the object of providing a 30 horse-power electric motor for doing the small amount of work mentioned, under normal conditions, was to allow for possible variation of water level. It has been possible to work with a difference of one-half foot in the level of the water in the troughs, giving an unbalanced load of about 28,000 pounds.

In order to obtain a clear idea of the method of operation of this plant and the reason such a small amount of electric power is required, it may be well to note the details of construction of the original hydraulic canal lift at Anderton, and the alterations made when hydraulic power was superseded by electricity.

The canal runs for some miles on the top of the bank parallel to the river below, the difference in level being about 50 feet. By the use of the hydraulic elevator, the lowering and raising of the vessel was accomplished without taking any great amount of water from the canal, the barges being lifted while floating in a trough of water, thus obviating any danger of straining the hulls should the cargoes shift; but to do this required the lifting of not only the barges and their loads, but the weight of the water in the trough as well. In order to reduce the amount of hydraulic power required to do this work to a minimum, two equal troughs were provided so as to balance each other.

which passed through a stuffing box in the bottom of the elevator pit, and through a tunnel into the hydraulic press of wrought iron measuring more than 4 feet in diameter and provided with valve boxes and stuffing boxes for adjustment and lubrication of the rams.

Cast iron presses and rams were utilized in three lengths 5½ feet in diameter, these cylinders being



THE ANDERTON HYDRAULIC CANAL BOAT ELEVATOR BEFORE ELECTRIFICATION.

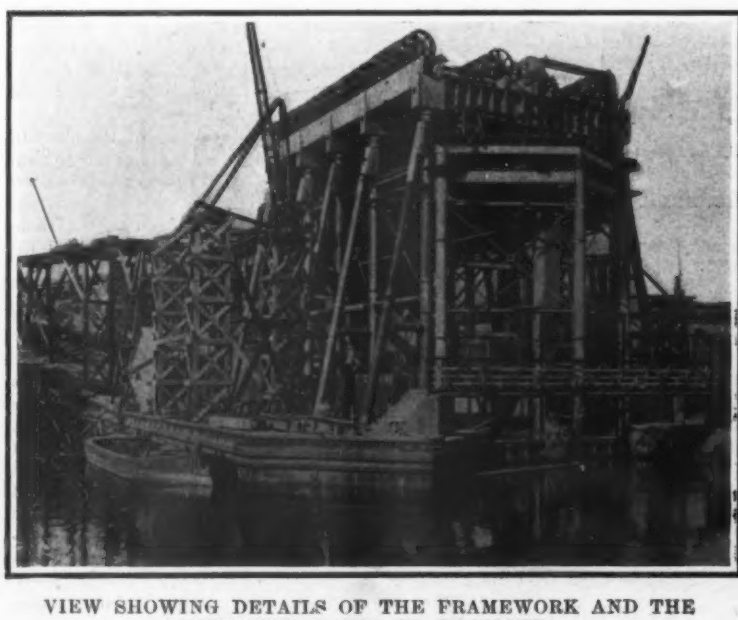
This hydraulic canal boat elevator was constructed with double troughs 75 feet long and 15½ feet wide, one trough to receive the barges coming down the river, which would assist in lifting the barges in the other trough up to the canal level.

These troughs were constructed of wrought iron, the sides forming girders 7½ feet deep at the end and 9½ feet deep at the center, which support the entire weight of the trough with a depth of water of 5 feet and the loaded barge. A lifting gate was provided at each end of the trough, and similar ones on the aqueduct, with cast-iron syphons at the side to secure whatever depth of water might be required according to the conditions of lifting.

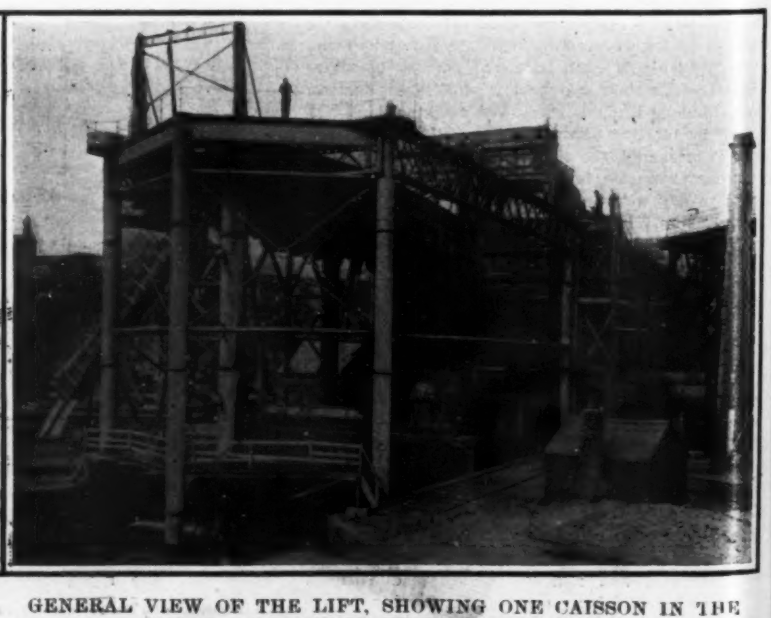
A wrought iron socket 3½ feet deep was fitted to the turned head of a cast-iron ram to which the draw was attached. From this socket wrought iron cantilevers were provided to take the weight from the side girder.

It will thus be seen from the illustration and the accompanying drawings that each trough was moved up and down by a vertical ram 3 feet in diameter, joined by bolts and flanges and held in place at the required depth by concrete about the cast-iron bed plate.

In order to keep the elevators steady when in motion cast-iron guide blocks were provided at the corners at each of the troughs, which engaged guides on the columns around the elevator pit, these columns being supported on foundations of concrete and brickwork. A hydraulic accumulator was provided to assist in working the canal boat elevator, the ram having a stroke of 13½ feet and a diameter of 1 foot 9 inches, and its capacity being equal to that of one of the main rams for four strokes of 4½ feet, while the two main hydraulic presses were connected by a pipe with an equilibrium valve for opening and closing communication between them. Additional pipes and valves were connected between the presses and the accumulator so that the latter, if desired, could be open to both or either presses, while waste pipes were installed to carry the spent water into the aqueduct. A safety valve was provided, permitting the release of pressure should the elevator be raised above the proper



VIEW SHOWING DETAILS OF THE FRAMEWORK AND THE ENTRANCE GATES TO THE LIFTS.



GENERAL VIEW OF THE LIFT, SHOWING ONE CAISSON IN THE UPPER AND ONE IN THE LOWER POSITION.

position, and all the valves for controlling the flow of water were operated from the cabin of the attendant through gearing and shafting, the operation of the elevators being extremely simple.

In case the weight of the two troughs were the same, including their loads, the apparatus would be in equilibrium when the troughs were at the same level, and the communication between the two presses open so that the water could freely pass from one to the other.

In case one trough, with its load, was heavier than the other, it would fall nearer to the lower level and force the lighter one up nearer to the canal level. If one trough was at the level of the aqueduct while the other was down in the elevator pit, and all the valves were closed, the lower trough containing water 4½ feet deep and the upper one 5 feet deep, as soon as the valve was open on the communication pipe, the lighter one would ascend and the upper trough would descend until it became partially immersed in the water in the pit, and it had lifted the other trough to within 4½ feet of the top. If the communication was then closed and the water in the press supporting the descending trough was run to waste into the aqueduct, the trough would descend into the water in the pit. In this manner the barges were lowered to the level of the river from the level of the canal, and the vessels could then be floated out by raising the gates. The upper trough was forced up to within six inches of the canal level by the operator in the controlling valve cabin opening communication between the ascending elevator press and the accumulator.

Between the aqueduct and the trough a water-tight joint was made by means of a round piece of India rubber 3 inches in diameter, so arranged that, as the ascending trough was lifted, the rubber was compressed between two surfaces, the ends of the aqueduct and trough being properly beveled for the purpose. As soon as the aqueduct gate was lifted, together with the trough gate, the water level was established and the barges passed through; after which the gates were again closed and the trough allowed to descend, the water between the gates passing through a pipe to the bit below and lost at each operation. By taking about 14 tons of water from the canal, or a layer of water only 6 inches deep, 15½ feet wide, and 75 feet long, the entire lifting operation of this hydraulic canal elevator was accomplished, the steam engine and pump only being required to perform 1/12 of the lift by hydraulic pressure.

It is remarkable to note that this construction was in constant operation from 1875 to 1902, when variable speed electric motors and pumps were installed, the current being supplied from a local electric power company. This electrification consisted in simply changing the prime mover for the auxiliary power from steam to electricity, the remaining equipment being the same with the exception of the aqueduct gates and elevator gates, which were operated directly by electric motors. The latter change saved the labor of three men in constant attendance, a small electric dynamo and storage battery being installed for supplying this current for operating the electric driven gates as well as for lighting service and for operating electric cranes on the adjoining dock. It is stated that by operating the electric pumps instead of steam driven pumps there was a great reduction in the working cost, which was very largely reduced when the present direct, motor driven equipment was installed.

The change in construction from hydraulic operation to direct electric drive was accomplished without interference with the traffic and with only three stoppages during the entire electrification. Electric motors of 5 horse-power each were installed for lifting the gates and operating the drainage pump, while the two main operating motors, each of 30 horse-power capacity, were equipped with automatic brakes and controlers of the electric railway type.

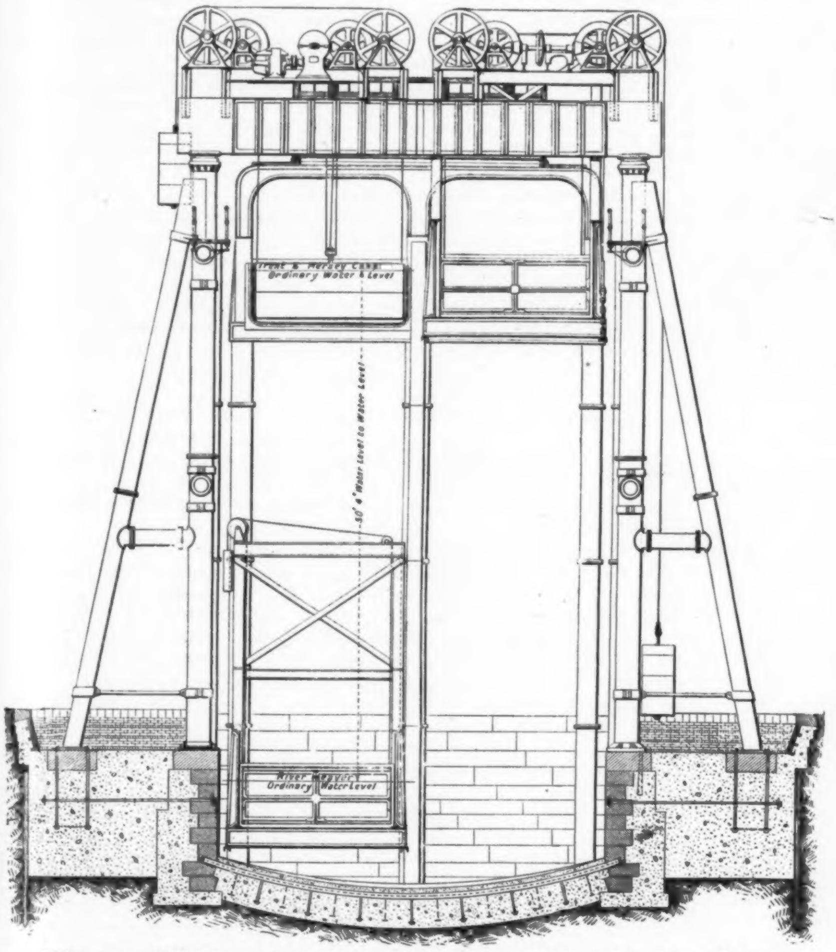
The operation of the elevator is extremely simple, depending entirely upon two equal weights counterbalancing each other, while the electric motive power is applied to turn the pulleys, through double helical gearing, and work the reducing gear, a number of ropes providing a proper distribution of the weight.

The electric power is applied to the main pulleys by means of an inclosed worm and wheel running at a speed of 18 revolutions per minute, the motor making 750 turns per minute. A longitudinal shaft is actuated by this worm wheel and conveys the power to two short cross shafts on the top of the structure, operating at 12 revolutions per minute, and located at equal distances from the center and from each end of the pulleys. There are two longitudinal shafts 70 feet long, running the whole length of the structure, and actuated by the worm wheel by means of bevel gear, the pinions engaging with each pulley so that the speed is reduced in this manner to three revolutions per minute. As the wheels are 6 feet in diameter and the pinions are each one foot in diameter, there is another reduction in speed which results in the main pulleys only making one turn in two minutes. In operation, only the whirr of the electric motor is heard, as there is an entire absence of noise and backlash, all the teeth being helical and every pulley directly geared to the shafts, while the torsion on the main shafting is equalized by the cross shafts, insuring the simultaneous movement of the pulleys.

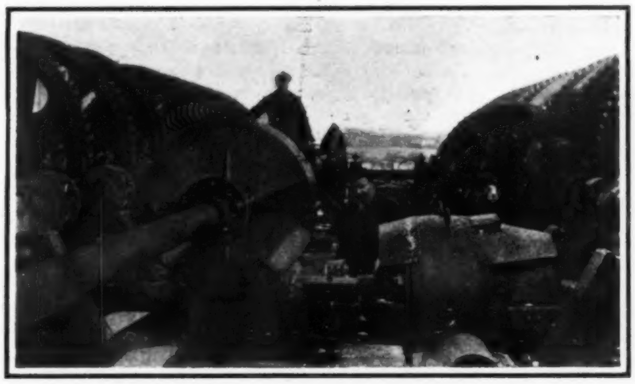
It is interesting to note that regardless of the weight of the barge and its load, the caisson with the water in it weighs almost exactly one half million pounds and the total weight does not vary, as the vessel always displaces its own weight of water and the caisson is counterbalanced by means of 36 groups of cast-iron weights, each group weighing 7 tons, and suspended by an independent rope over a six-foot pulley. It will be seen that, whatever the stretch of the rope may be, the stress cannot be more than the friction between the pulley and the rope, together with the 7-ton plate, and uneven stresses are relieved, as practically the whole length of the rope is hanging free when the trough is at the top.

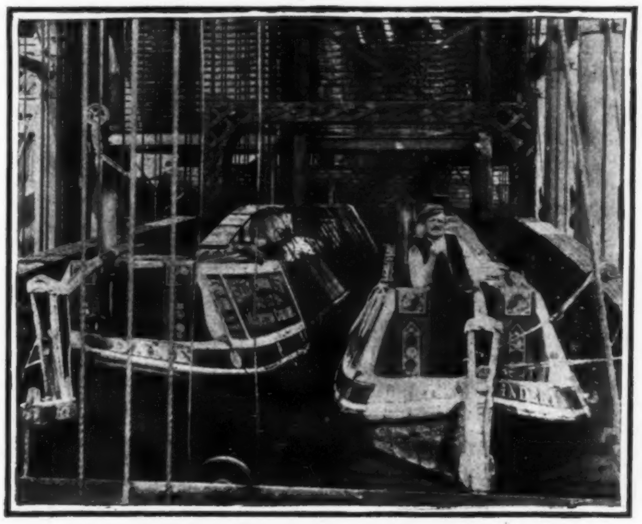
This will clearly show why, as before stated, the electric power required to operate this elevator is only that necessary to overcome the friction of the pulleys and guides. It clearly indicates why only 8 horse-power is required for a period of from 5 to 6 minutes to accomplish the movement of 570 tons, or over a million pounds, through a single stroke of 50 feet.

The economy of operation is of importance, and the labor required by the operator in charge of the controllers is far less than formerly, when the movement of valves operated the hydraulic equipment. Under the present construction and method of operation, as soon as the electric power is switched off, the cost of current ceases, and for intermittent work it is maintained that electric power is the most satisfactory and economical that can be employed.



THE ELECTRICALLY-DRIVEN CANAL BOAT ELEVATOR OF WEAVER RIVER.


ELECTRIC MOTORS AND GEAR ON TOP DECK.


COMPLETE LIFT, SHOWING BOATS IN CAISSON.

FOUNDRY FLASKS—UNITED STATES STANDARD.

On account of the variation of castings for flasks, all measurements as to list sizes must be made on the inside at the parting line, and the sizes listed at the full half-inch found next below the actual measurement. (To, illustrate: Should the actual width be 12⅝ inches and the length say, 14 3-16 inches, it must be listed as 12½ by 14.)

The location of the pin-holes is not to be made from the actual measurement of the flask, but from the list size as same is provided for above.

In locating the pin-holes, the measurements must be made from lines drawn at right angle through the actual center of the flask, and the distance apart along the sides of the flask from center to center of the pin-holes must be exactly three-fifths (3/5) of the list length (or 3/10 from the actual center line). The distance apart across the flask must be exactly three inches (3 inches) greater than the list width, or one and a half inches more than from center line to center of pin-holes.

For flasks of less than 500 square inches of surface measure the pin-holes must be exactly a half inch (½ inch) in diameter.

The above applies to flasks of all depths.

LIGHT AND ELECTROMAGNETISM.*

ELECTRIC WAVES AND THE ELECTROMAGNETIC THEORY OF LIGHT.

Concluded from Supplement No. 1808, Page 132.

IN opening the concluding lecture of his course at the Royal Institution on the subject of electric waves and the electromagnetic theory of light, Sir J. J. Thomson said that on the previous occasion he had shown that it followed from the principles of electricity and magnetism that an electric disturbance traveled with a velocity equal to $\frac{1}{\sqrt{k\mu}}$ where μ denoted the magnetic permeability and κ the specific inductive capacity of the medium. The disturbance in question consisted of lines of electric force traveling at right angles to their own direction, and of lines of magnetic force perpendicular both to the electric force and to the direction of its motion This velocity, when calculated from the data available for air, proved to be the same as that of light in the same medium. Hence arose the suggestion that light itself was an electric disturbance. He had, he continued, already discussed the effect of the dielectric, and shown that in many cases the speed of light in a medium was not proportional to the square root of the specific inductive capacity. There were many reasons, such as "anomalous" dispersion, which would account for the discrepancy in question.

All knew, he proceeded, that metals were opaque to light, and he was afraid that a really transparent metal was contrary to the order of Nature, and that it would, to the end of time, be necessary to put up with apparatus of glass in their laboratories, in spite of its many defects. Though, as stated, all metals were opaque, precise measurement showed that they were really more transparent than they ought to be. Taking a piece of gold leaf, prepared by Faraday himself, the lecturer showed that it transmitted quite an appreciable amount of light, which was of a green color. Given the specific resistance of the metal as usually measured, it was, he proceeded, possible to calculate how much light should pass through gold leaf of a given thickness; but experiment showed that the quantity which actually passed was more than was consistent with the view that resistance of the metal in these thin films was the same for rapidly-changing as for steady currents.

Experiments by Rubens and Hagen on the transparency of metallic films to light of different wave-lengths had, Sir Joseph proceeded, thrown a great deal of light on the mechanism of conduction. Some of the most notable results had been obtained with light drawn from the infra-red portion of the spectrum. It was found that until the wave-length of light was reduced to 2.5×10^{-3} centimeters the transparency was in exact accord with that calculated from the resistance of the gold. It was only when the wave-length fell below this critical value that the leaf became more transparent than it ought to be. The discrepancy increased with decreasing wave-length, and for the visible portion of the spectrum generally much more light got through than ought to. This observation, as he had already said, threw much light on the mechanism by which the current was carried through the leaf. If the carriers were electrified particles acted on by electric force, then moving under the latter, they would acquire energy, and when they finally struck a molecule this energy would be given up and converted into heat, the metal getting hot. If, however, the alternations of the electric force were so frequent that its direction changed during the time taken by the carrier to pass from one collision to the next, this carrier would acquire little energy, and consequently give up little on finally colliding with a molecule. Hence, if the distance between two collisions was relatively large, there was considerable transparency, and from the measurement of this transparency the distance traversed by the particle carrying the charge between successive collisions could be calculated.

There was, he proceeded, another case in which electric conductivity did not destroy transparency, as, for example, in very dilute sulphuric acid. In this case it was found, however, that when very long waves were used, they were absorbed in quite the right proportion; but in the case of visible light the conductivity disappeared, and the liquid became transparent. Here, again, valuable information could be obtained by finding the critical wave-length at which the discrepancy arose.

In addition to transparent conductors, there were, he said, opaque insulators. A great deal of this opacity could be explained by the fact that most of such insulators were not uniform in composition. The effect of this want of uniformity the lecturer illustrated by repeating an experiment of Christiansen, in which powdered glass was immersed in a mixture of bisulphide of carbon and benzol, having the same refractive index. When thus immersed, the mass of powdered glass was quite transparent, while on draining off the fluid it immediately became opaque. Here the opacity, Sir Joseph said, was due to repeated reflections from the faces of successive fragments of glass. These reflections did not arise if the glass were immersed in a medium having the same refractive index. The opacity of many dielectrics arose in the same way, and was well accounted for by the electromagnetic theory of light which had special advantages in the discussion of reflection and refraction, the conditions at the surface producing the phenomena in question being in this theory definite.

He would next, he said, proceed to some electrical effects having analogies in optical phenomena. One of the most notable of Faraday's discoveries at the Royal Institution was the rotation of the plane of polarization when polarized light was passed through a magnetic field. The Hall effect in electrical conduction was due to a precisely similar cause. Prof. Hall, working in Rowland's laboratory at Baltimore, had found that when a conductor conveying a current was placed in a magnetic field, the lines of flow of the current were displaced, the field introducing, in fact, an additional electromotive force, tending to produce a flow at right angles both to the original stream-lines and to the magnetic field. The phenomenon, the lecturer continued, was particularly easy to observe in the case of a gaseous conductor, in which the current was self-luminous, and the displacement caused by the field was thus directly visible. Accepting the Hall effect, what, the lecturer continued, should be the result when polarized light passed through a magnetic field? With polarized light the lines of electric force which constituted the wave were all parallel to each other. If such lines traversed a magnetic field, they would be turned round, and this was equivalent to a rotation of the plane of polarization. The effect was particularly well shown when the polarized light traversed a medium which strongly absorbed it. To show this, he passed the light from an arc-lamp through one nicol to polarize it, and through another which quenched it. A sodium flame was arranged between the two nicols, each resting on one pole of an electro-magnet. On energizing the magnet, the plane of polarization of the sodium rays was so changed that the crater of the arc could be seen through the nicols, showing up in brilliant yellow light, the remainder of the rays of the spectrum being still unable to pass the second nicol.

Some other effects of light had, Sir Joseph proceeded, caused physicists to consider the possibility of the wave-front being rather different from what it was usually considered to be. When ultra-violet light was incident on a metal, it caused it to give out negative electricity; and were the metal originally negatively charged, this charge was rapidly dissipated, while, on the other hand, a positive charge was retained. Some points connected with this phenomenon were very singular, and, as stated, had caused physicists to contemplate a modification in the previously accepted view of the structure of a light wave. It was possible to measure the velocity of the negative particles given off by a metal under ultra-violet light, and this was found to be quite independent of the intensity of the light. If the metal were close to the source, the number of particles liberated was more than if the two were widely separated, but the velocity of the particles was in both cases identical. This fact was very peculiar, since if the particles owed their speed to the electric force accompanying the light-wave, it would be natural to expect higher speeds with the more intense lighting. On the old emission theory, on the other hand, the result observed was exactly in accordance with what one would anticipate. Anything done by a single "light particle" could be done just as well after a travel of 1,000 miles as at the origin. Hence, if the negative particles were shot off from the metal by the impact of the light particle assumed in the emission theory, it was to be expected that the speed of the negative particles thrown out would not depend on the distance of the metal from the source.

It was possible to determine the number of these negative particles sent out in any stated time, and this number proved to be a very small fraction of the total number of molecules on the surface on which the ultra-violet light was incident. If a light-wave were perfectly uniform, having, so to speak, no holes in it, each molecule on the surface struck by the light would experience the same electric forces. By allowing the light to fall on the surface for a few seconds there would be ample time for effects to average out; but observation showed that apparently only a small fraction of the molecules exposed to the light gave off negative particles. This fact would also fit in well with Newton's emission theory, for then only a few of the molecules on the surface would be struck by the particles of light. Many had accordingly been led to conceive that the front of a light-wave was not continuous, and that, could it be actually observed, it would not appear as a uniformly illuminated surface, but rather as a series of light specks on a dark ground. Considering electric phenomena only, there was indeed a great deal to be said for supposing that light consisted of little bundles of electric and magnetic force, the wave-front having, as it were, a molecular structure. There was no necessity for such a theory when optical phenomena alone were considered; but taking the electric properties into consideration, physicists were almost driven to see whether such a view as that suggested was not also in accord with ordinary optical effects.

The only difficulty arose in connection with the phenomena of interference. To produce these it was necessary that the phases of the supposed bundles of electric and magnetic force should not be arbitrary, and this might appear an objection to the view that the front of a light-wave was not uniform. Within somewhat intense light, such as was generally used in interference experiments, it might be possible that enough of the many bundles then emitted might be sufficiently in phase to admit of interference, and it had, therefore, appeared to the speaker of interest to test whether interference effects could be obtained with light of very feeble intensity. The experiments had been carried out in the Cavendish laboratory by Mr. Taylor, who, using light so feeble that it required six weeks to obtain a good photograph of the interference fringes, found that these were just as definite as with ordinary light. The speaker was, however, not at all convinced that it was possible to obtain from a luminous body bundles of electric and magnetic force very different in phase. The vibrating particles giving rise to the emission would act on each other by resonance, and as the bundles of force traveled through luminous gases they would excite secondary disturbances also in phase with themselves, so that he thought there was probably a definite phase relationship between all the assumed "molecular" constituents of the wave-front.

A theory had been developed by Plancke which made the energy in each bundle of lines of force proportional to the frequency, so that the energy was more in ultra-violet light than in red or yellow. Prof. Thomson could not himself, however, reconcile this view with the existence of interference effects with very feeble light. Calculating on Plancke's theory, it would appear that in Mr. Taylor's experiment there was only one bundle of lines in each liter of space. He could hardly imagine, therefore, that units so widely separated as these could give rise to interference. On the other hand, it was a fact that the energy which came off when metals were exposed to ultra-violet light did depend on the frequency of this light, the speed of the particles emitted being higher the shorter the wave-length of the incident light, so that these experiments agreed with Plancke's view that the energy of the light was proportional to its frequency.

Another development of these experiments was the comparison of the velocity of the particles emitted when a metal was struck by Röntgen rays with that when the agent was ultra-violet light. With the former the speed developed was hundreds of times as great as when ultra-violet light was used. If the rule held that the energy was proportional to the frequency, the frequency of the Röntgen rays could be thus calculated, and the latter would thus appear to have a wave-length equal to 10^{-8} centimeters, or about the conventional size of an atom.

We might thus, he concluded, look forward to getting a considerable extension of our present views as to the nature of light by the study of the electrical properties connected therewith. As already stated, these had already given rise to a serious questioning of the formerly-accepted view as to the structure of the wave-front. Further experiments were necessary, but in its main features the electromagnetic theory must be considered as most firmly established, and constituted a great triumph for British science, which, whatever modifications it might receive in the future, would always remain a memorial to Clerk Maxwell, one of the greatest and best-beloved of English men of science.

* Engineering.

TELE-PHOTOGRAPHY.*

A SYSTEM OF TRANSMITTING OPTICAL IMAGES ELECTRICALLY.

BY HENRY SUTTON.

UNDER various names the problem of transmitting optical images by aid of the telegraph wire has at different times had attention drawn to it.

In telephotography we are met, at the outset, with a great preliminary difficulty, having to deal with a surface or plane in which the effect appealing to the brain must be observed in all the varying character at one and the same time.

The problem stands thus: a means has to be devised whereby the varying effects on a plane surface are translated into consecutive series of electrical currents, and by means of the consecutive series of currents reconstruct, so to speak, a copy of the original surface; that is, we have to take an optical image, seen as a surface, translate it into a line of consecutive varying electrical currents, and by means of these produce an effect as a surface, having the characteristics of the original image.

We have here two images as surfaces having no time value, and a series of electrical currents having a time value, yet these opposing characteristics are to be presented to the brain as a momentary impression.

Before showing how this apparently impossible problem may be handled, I will explain a probable means for electrically transmitting a photograph.

If we make what photo-mechanical operators call a screen negative of a portrait, using a coarse screen, and from this a photo-lithographic transfer, transfer it to zinc, and transmit the result by any of the several autographic systems, we have the desired result. In fact, if we apply our knowledge of half-tone block making to telegraphy, we are at once in possession of a means of electrically transmitting the photographic semblance of any person.

We may make a screen negative, and from that obtain a print on zinc or copper coated with sensitive albumen or bitumen, using the usual solvents, water or turpentine, as the case may be, with which to wash away the unexposed albumen or bitumen, then let the stylus of any autographic system traverse the developed image, the result at the receiving end is a facsimile portrait. I have used the expression screen negative, as it is an understood trade name; as a matter of fact, a screen positive would be necessary. We may go further: instead of receiving the facsimile on chemically-prepared paper, as in the Caselli autographic telegraph, we can make the receiving stylus perforate thin paper (with the electric spark) by means of a constantly-working induction coil, but only put into the receiving circuit by the transmitted current. Place this paper on a lithographic stone or zinc plate, pass a roller charged with greasy ink over it, and we have a printing surface, the portrait being transmitted and reproduced for the printer, photo-electro-mechanically.

But this is not telephotography; the latter must be understood as the means of transmitting images which may be in motion, as seen in a photographic camera, but not in colors.

Having spent some years in studying the problem, I designed the following system five years ago, as my Victorian scientific friends can testify. It may be of much assistance to workers in this direction. I think that it offers a fair approximation to the solution of this very difficult problem; at any rate, if in its present form it is not the actual solution, I feel sure that it is in the direction indicated by my method that the successful accomplishment of telephotography will result.

TRANSMITTER.

L (Figs. 1 and 5) is a photographic objective of the rapid type, producing an intensely illuminated aerial image at *A A*.

D D (Figs. 1, 2, and 5), light metal disk revolving at a fixed rate of not less than 650 revolutions per minute under the control of a La Cour's phonic wheel and fork apparatus as in the Delany multiplex system.

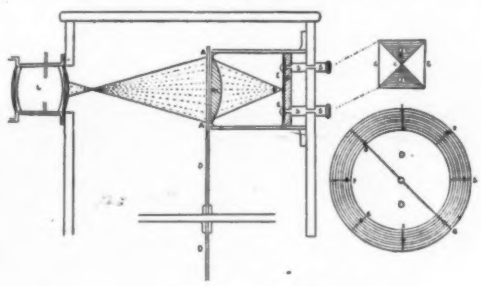
G (Figs. 1, 3, and 5), a glass or other insulating plate, to the front surface of which is held, by binding terminals, *S S*, two triangular pieces of metal just separating from each other, *E E*.

C (Figs. 1, 3, and 5), a small piece of lamp-black, selenium, or other substance, the resistance of which may be varied by heat or light. Lamp-black compressed is probably the most suitable.

The disk, *D D*, has a series of small holes, 1, 2, 3, 4, 5, 6, 7, 8, perforated in it, and gradually approaching its center, as a spiral; these holes must be numerous, and yet only one at a time in the field of the image at *A A*.

R L (Figs. 1 and 5) is the most important part of the transmitter. This I term the regulating lens; it is a lens placed with its plane surface just to receive the aerial image from the objective *L*, its focal length being such as to bring all rays reaching it through the perforated disk to a point or focus at *C*, and therefore its function is to introduce them consecutively to the circuit comprised in *S*, *E*, *C*, *E*, *S*, at *G*.

Under the influence of this regulating lens the whole image, *A A*, is allowed to act in consecutive manner, and therefore vary the resistance of *C* in accord with the lights and shades of the original. We thus solve the big problem of translating the plane image into a line of consecutively varying strength of current, and by bringing *C* under the influence of the whole image within one-tenth of a second, and during the same time reconstruct our image at the receiving station,



FIGS. 1, 2 AND 3—TRANSMITTER.

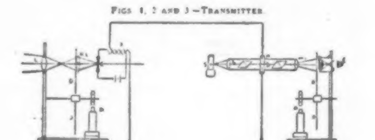
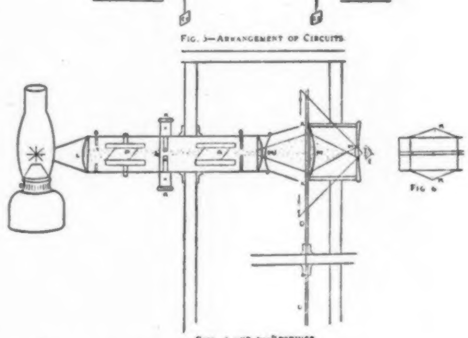


FIG. 3—ARRANGEMENT OF CIRCUITS.



FIGS. 4 AND 5—RECEIVER.

THE TELE-VISION APPARATUS, 1890.

persistence of vision will enable us to see the image as one impression.

RECEIVER.

S (Figs. 4 and 5), any artificial source of light, a beam of which is by means of lens, *L*, passed through a pair of Nicol prisms, *P*, *A*; this beam reaching lens *M*, is magnified and received by the eye-piece, *M*, *M*, and viewed by the eye, *E*. It is absolutely requisite that this beam should be received by the eye through optical means. The presence of a translucent screen at *X*, *X*, would be fatal, owing to the delicate nature of the desired effect.

D D (Fig. 4) is a perforated disk, similar to and revolving synchronously with the disk in the transmitter.

K K (Figs. 4, 5, and 6), terminals inserted in glass and having a small space between, holding a drop of bisulphide of carbon, *S*.

On rotating the Nicol, *P*, 45 deg., we reach the position of extinction.

The terminals, *K K*, being placed in the secondary circuit of the transmitter—that is, to line—the variable electrostatic strain produced in the drop of bisulphide of carbon under the action of induced currents received from the transmitter, is to produce variable rotation of the polarized beam, and, therefore, variable qualities of light reach the eye, *E*.

It is obvious that the varying tints will be seen in similar position as in the original image, owing to the synchronous movement of the disks.

The receiver is, then, based on Dr. Kerr's discovery of the rotation of a plane polarized beam of light, through electric stress producing a strain in the medium.

There seems to me no question that the electric impulses will do their work within one-tenth of a second, and the point is whether the stress at *O O* will be sufficient to produce an observable effect, and whether this may be increased by passing the light through a bisulphide of carbon cell having a longer path of, say, one-sixteenth inch diameter, as shown at Fig. 6, instead of through the drop of bisulphide; so that, conceding that the apparatus is based on a rightly conceived principle, it becomes a question whether the quantitative results of the physical effects utilized in its design are sufficiently great.

I think the transmitter may be considered as near the right thing as the present state of our knowledge will admit us to reach; there is an appearance of finality about it.

With regard to the receiver it is a question of degree; the actual quantity of light required to reach the eye may be very small when received optically; in fact, so small as to have no power of illumination on a translucent screen; but a quantity of light producing no visible effect on any media, when received by means of an eye-piece shows a bright disk. Owing to being away from references, I regret my inability at the moment to give the name of the inventor of the revolving disk; with the exception of these disks the whole design is original, and was devised at Ballarat, Victoria.

* Reprint from the Telegraphic Journal and Electrical Review, London, Vol. xxvii, No. 676.

SOME MINUTE PHENOMENA OF ELECTROLYSIS.

IN the Proceedings of the American Academy, Mr. H. W. Morse describes certain minute phenomena that accompany electrolysis. So far only qualitative observations have been made. If pure water be electrolyzed between small silver electrodes at voltages ranging from 1.40 to about 3.8 volts, and the space between and about the electrodes be observed under the microscope with powers of 50 or so, the following phenomena may be seen. A very short time after the circuit is closed a cloud of very small brownish particles, in rapid Brownian movement, is formed near the anode. A silver foil anode dissolves rapidly, and a dark film of silver oxide remains. The particles first make their appearance at a slight distance from the anode, and appear to be due to the formation of a silver compound produced from the silver which has dissolved and one of the constituents of the water. This cloud consists of approximately spherical particles of diameter 0.3-1.0 μ; the particles appear to be silver oxide. A thin cloud, the particles of which are metallic in appearance, may also appear about the kathode, only to disappear suddenly later on, when the growth of metallic Ag begins at the front of the kathode. The above-described effects appear in the purest obtainable water, and they are most evident in the best conductivity water. Electrolytes in very small concentration prevent the effect completely, and cause the appearance of the usual gas bubbles at the anode and kathode. While the above effects are making their appearance in the electrolyte nothing whatever happens at the kathode itself. The space between the electrodes may be active for several minutes without the appearance of either a bubble of gas or a crystal of Ag. A magnetic field has no definite effect on the particles. An adaptation of the microbalance was used to follow the changes in weight at each electrode during the electrolysis, with the following qualitative results: Immediately on closing the circuit a very slight decrease in the weight of each electrode was observed in four out of six experiments. Thereafter for several minutes an increase in weight of each electrode took place, the anode gaining much faster than the kathode. The increase in weight of the anode is due to the formation of silver oxide or peroxide; that of the kathode to the deposition of Ag. Finally, there is a decrease in weight at the anode and increase at the kathode.

According to African Engineering, among the railway works which it is proposed to carry out in Natal during the next financial year are: Extensive main line improvements to facilitate and cheapen haulage, increased siding accommodation at stations, additional workshop accommodation to meet demands for repairs to locomotives and rolling stock, new locomotive sheds and yard at O.R.C. junction (now in hand), traffic marshalling and storage yard at Congella, and additional engines to replace some of the worn-out "Reid" type.

HOW FISH ARE HATCHED.—II.*

FISH-CULTURAL PRACTICES IN THE UNITED STATES BUREAU OF FISHERIES.

BY JOHN W. TITCOMB, ASSISTANT IN CHARGE OF THE DIVISION OF FISH CULTURE.

Continued from Supplement No. 1808, Page 139.

Lake Trout.

THE station at Northville, Mich., with its several other lines of fish culture, is also the principal center of the lake trout work, and has a record of over 58,000,000 such eggs in one season.[1] As the spawning season is short, however, and is at a period of the year when the fishermen, on account of rough weather, often cannot set or take up their nets at will, the collection of eggs must necessarily vary in quantity and quality from year to year, according to weather conditions.

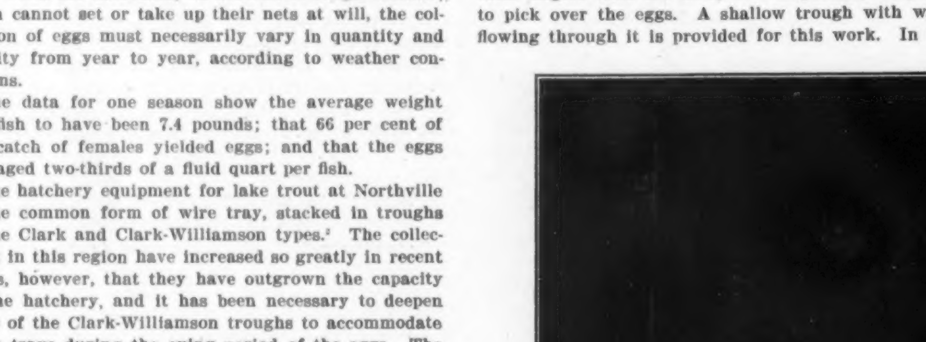


FIG. 9.—CLARK-WILLIAMSON TROUGH.

The data for one season show the average weight per fish to have been 7.4 pounds; that 66 per cent of the catch of females yielded eggs; and that the eggs averaged two-thirds of a fluid quart per fish.

The hatchery equipment for lake trout at Northville is the common form of wire tray, stacked in troughs of the Clark and Clark-Williamson types.[2] The collections in this region have increased so greatly in recent years, however, that they have outgrown the capacity of the hatchery, and it has been necessary to deepen some of the Clark-Williamson troughs to accommodate more trays during the eying period of the eggs. The deeper troughs are 15 feet long and 3½ feet wide, with a division through the center of the entire length; the width therefore is that of a pair of troughs having a common bottom. The outside depth is 18 inches. Each of the deep troughs contains, besides the bulkhead, 15 compartments 19 inches by 10 inches by 16½ inches deep, with a capacity of 16 trays 18½ inches long by 9½ inches wide, on each of which may be placed, if crowded, 10,000 eggs. The total maximum capacity of each pair of troughs is then 4,800,000. For best results, 8,000 eggs to the tray, or a total of 3,840,000 to each pair of troughs, is a proper number.

During incubation the eggs seem to do equally well in either up or down current of the Clark-Williamson troughs; at other stations where eggs are incubated in stacks of trays the Williamson type of trough is used.

As lake trout eggs are taken from fish that have been caught in nets hauled into fishing tugs by steam power, often during rough weather and frequently after the nets have been inaccessible for several days, the percentage of good eggs is not equal to that secured from most of the species manipulated. Consequently a large force of young women, who are more deft with their fingers than are men, are temporarily employed to pick over the eggs. A shallow trough with water flowing through it is provided for this work. In this trough, standing above the water on four short legs, are wire baskets, one for each egg picker, into which to throw the dead eggs. The farther side of each basket, to the picker's right, has a high back to stop the eggs as thrown from the tweezers, thus making it unnecessary for the eyes of the picker to follow each egg, and thereby facilitating the entire operation.

THE BROOK TROUTS, CHARS, AND EASTERN SALMONS.

For brook trout eggs (*Salvelinus fontinalis*) the Bureau depends largely upon commercial trout raisers, eyed eggs being obtained from them at lower cost than it is possible to collect from wild fish at most places or from brood fish maintained only for their eggs. About 8,000,000 eggs are annually purchased from ten to eleven dealers. For the purpose of making a just comparison as to quality and final cost of fish produced from each purchased lot the eggs received from each dealer are distributed to several hatcheries, that all may be alike subject to different conditions of quality and temperature of the water supply.

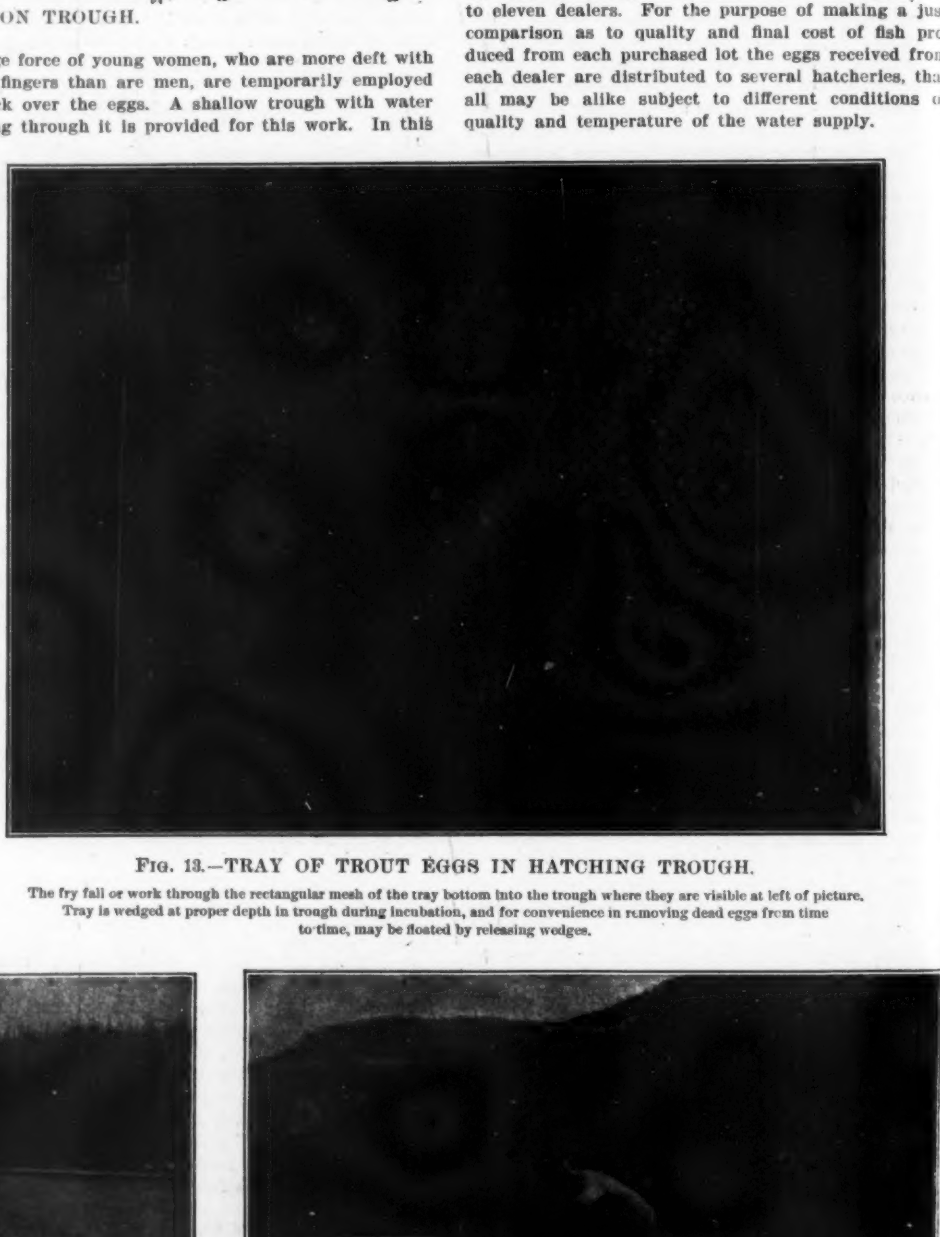


FIG. 13.—TRAY OF TROUT EGGS IN HATCHING TROUGH.

The fry fall or work through the rectangular mesh of the tray bottom into the trough where they are visible at left of picture. Tray is wedged at proper depth in trough during incubation, and for convenience in removing dead eggs from time to time, may be floated by releasing wedges.

* Address before the Fourth International Fishery Congress, held at Washington, D. C., September, 1908.

[1] Since this writing another spawning season has yielded 71,000,000 eggs at the Northville station.

[2] For full description of these troughs see Manual of Fish Culture, pp. 97-99.

FIG. 10.—CAPTURING SPAWNING BLACK-SPOTTED TROUT IN SMALL TRIBUTARY OF GRAND MESA LAKE, COLORADO.

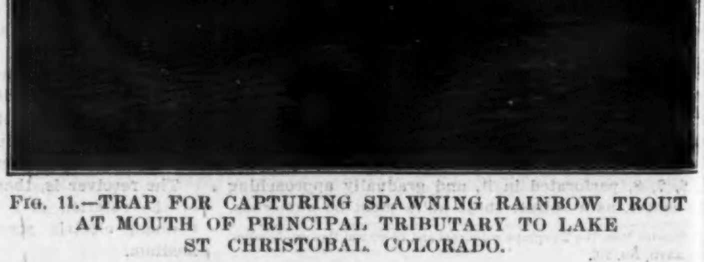


FIG. 11.—TRAP FOR CAPTURING SPAWNING RAINBOW TROUT AT MOUTH OF PRINCIPAL TRIBUTARY TO LAKE ST CHRISTOBAL, COLORADO.

At some stations, however, eggs from wild trout are more satisfactory. It has been found that eggs from the domesticated fish hatched and reared in spring water which is not subject to seasonal variations do not produce good results where the temperature of the water supplying the hatchery is below 35 degrees or is subject to variations of several degrees. Vermont and Colorado are the only States in which eggs of the wild brook trout are collected in sufficient numbers to stock the Bureau's hatcheries in those States as well as to have a surplus for distribution to other hatcheries. It is interesting to note, further, that in Colorado, where the eastern brook trout is an introduced species, the eggs can be collected in greater numbers and at less cost than in any other State.

In Vermont[3] eggs are obtained from trout inhabiting artificial lakes on private preserves. During September and October principally, but in some localities beginning sometimes as early as July and continuing into November, the fish ascend the streams in large schools on each rise of water. The fish culturist has only to provide suitable racks and traps in anticipation of the period of migration, constructing them in the streams that have been dammed to make the lakes. The fish are dipped from the trap into adjacent pens above the rack, the pens being kept covered to guard against the escape of the fish in case of a flood.

A field station of this character is sometimes managed by one man, who constructs the trap, rack, and pens, cares for and strips the fish, and then cares for the eggs, which are incubated until eyed in stacks of trays in the Williamson type of troughs, then packed and shipped to the central station at St. Johnsbury.

The construction of the racks under the many varying conditions which are wont to prevail requires good judgment and extreme care. Such barriers must be made in anticipation of and providing for floods, and must be fish-tight. One small hole large enough for the entrance of one fish may result in the escape of the entire lot.

The eying stations adjacent to these collecting stations are small inexpensive structures, a shanty 12 by 16 feet being adequate to eye a million eggs.

To compensate for the eggs taken from these waters, about 25 per cent of the fish produced therefrom are returned to them, this being an ample proportion to keep them well stocked. The parent fish are returned to the waters from which they were captured.

Eggs of the landlocked salmon (*Salmo sebago*) are collected by methods quite similar to those pursued in the brook trout work. Although the range of this species has been extended, the field of egg-collecting operations is almost exclusively the native habitat in Maine.

Perhaps the most extensive trout-culture operations in the world are conducted from the station at Leadville, Colo., in connection with which are field stations for the collection of eggs of wild trout of three species. The output of the Leadville station for 1908 was as follows:

Species.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Landlocked salmon	......	......	8,400
Rainbow trout ..	45,000	100,000	144,000
Black-spotted trout.	1,404,100	3,736,000	210,000
Brook trout	1,833,900	1,905,000	380,500
Grayling	......	50,000	......

[3] Titcomb, J. W.: Wild trout spawn; methods of collection and utility. Proceedings of the American Fisheries Society for 1897, pp. 73-86.

Spawntaking in Colorado.

To see the methods of work in Colorado it may be well to follow the spawntakers as they leave their camp on one of the Grand Mesa Lakes for a day's work with the native trout of the Rocky Mountains (*Salmo clarki*) at Big Island Lake, 10,000 feet above the sea level.

Each spawntaker is provided with a neck yoke and two ten-quart buckets in which to bring in the results of the day's operations. The fish have assembled in great numbers around the outlet of the lake, where as many as can be conveniently handled are caught at each haul of the seine and the ripe ones immediately stripped. Work at this point may continue all day or it may be advisable after a time to seek other spawning grounds, perhaps at the mouths of small inlets where the water from melting snow is flowing into the lake.

A most interesting phenomenon in connection with this work is the run of trout around the island from which the lake derives its name. Every two or three years, and possibly more often, at some period during the spawning season there is a procession of fish in twos, threes, and fours around this island. They follow the indentations of the shore line closely. There is no apparent break in the procession, the line being visible from any view point on the shore. It usually continues, moreover, for several days. A 200-foot Baird collecting seine run from the shore line of the island to form an obtuse angle intercepting the run for ten minutes will be full of fish. The spawntakers, standing about the bag of the seine, in two or three feet of water, proceed to strip the fish in the seine while the procession closes in, the line of trout winding in and out about the legs of the men and apparently in as large numbers as before.

The spawntakers with their full pails of spawn proceed to a station near their headquarters, where all eggs are spread on trays and the latter are stacked closely in Williamson troughs supplied with water from an adjacent lake. Here the eggs are eyed preparatory to shipping a portion of them to the Leadville and other stations. Some are hatched at the field station to replenish the waters from which they were collected, or other waters in the vicinity.

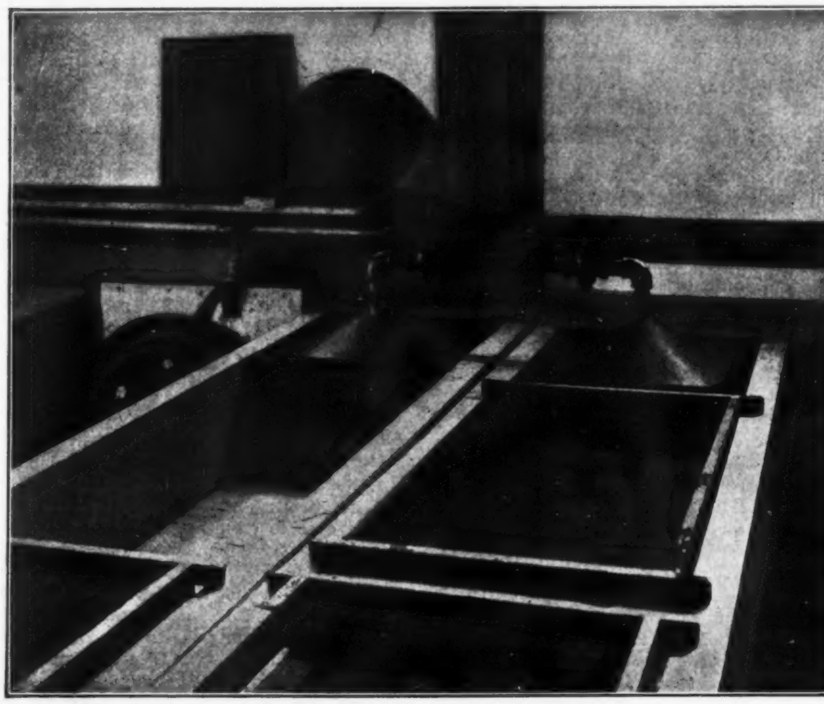


FIG. 15.—TROUT-HATCHING TROUGHS WITH MERRILL AERATING CONE.

Shows also tray basket of pattern used at some trout stations, much deeper than ordinary tray and intended to hold fry after hatching. Left trough with tray removed to show shower of water produced by aerating cone.

Rearing Methods.

At most stations a portion of the fry are reared to fingerlings, and at some stations it has been found advisable to carry brood fish, both of brook trout and rainbow (*Salmo irideus*).

The latter, a native of the streams on the Pacific coast, has been domesticated and successfully propagated at stations in Missouri, Iowa, Virginia, West Virginia, and Tennessee. At stations farther north whose minimum water temperature is usually lower and subject to extreme changes, it has been cultivated with varying, but on the whole rather negative, results. It has been successfully acclimatized in some of the more northerly States, notably in Michigan; but it does not thrive in waters subject to extremely low temperatures during the winter months, and in New York and the New England States has proved in most streams a failure.

The domesticated brood fish of either species are usually the product of eggs collected from wild fish, and are reared in the usual manner. The young fish

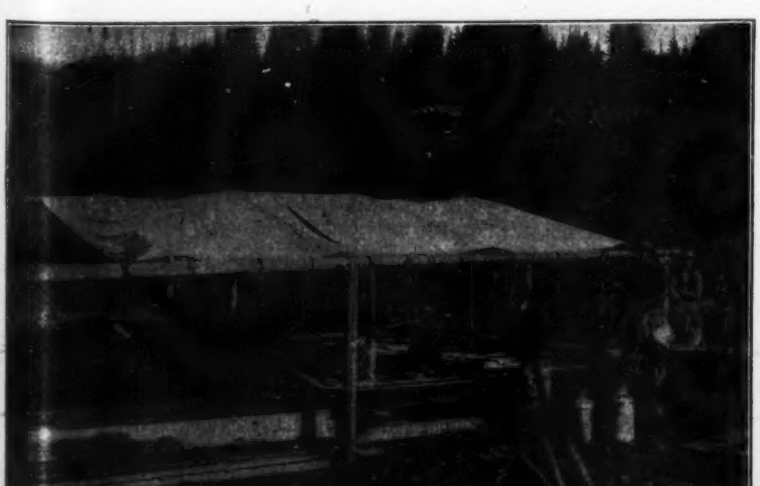


FIG. 12.—FIELD HATCHERY AT GRAND MESA LAKES, COLORADO.

Black-spotted trout eggs to the number of 7,000,000 in one season have been developed here to the eyed stage with only a normal loss.

FIG. 14.

Series of covered trout-hatching troughs at White Sulphur Springs station (West Virginia) equipped with the Robinson pan aerator.

may be confined for the first four or five months, or until 3 to 5 inches in length, in the hatching troughs or in a battery of outdoor rearing troughs of dimensions and in other respects quite similar to the indoor troughs, about 12 feet long by 14 inches wide. Care must be taken, however, to guard against overcrowding as the alevins increase in growth. The actual number of young fish of a given age which can be successfully carried is dependent upon the quality of the water supply, temperature being an important factor, not only as to the number for a given space, but also as to their rapidity in growth. At the White Sulphur Springs (W. Va.) station, with a supply per trough of 10 gallons of water per minute at a temperature of about 50 deg., it is customary to hatch and hold in each trough 50,000 sac fry, 25,000 advanced fry, 12,500 1¼-inch fingerlings, 4,000 1½-inch fingerlings, 2,000 1¾-inch fingerlings, and 1,000 fish 2 to 3 inches in length. Much larger numbers are often carried under similar conditions without serious loss, though often with the result that the fish prove weak in transportation.

At stations where the facilities permit, a congested condition of the hatching troughs is avoided by transferring some of the fish to outdoor ponds as soon as they have learned to take food readily, or, if weather conditions are suitable, after being fed two or three weeks. In rearing fingerlings for four to six months, concrete ponds 18 to 25 feet in length by 5 to 6 feet in width and 2½ feet deep, with a fall of 8 to 10 inches in the bottom for drainage, give good results at the Manchester (Iowa) station. The stock ponds at Manchester, 76 feet long, 17 feet wide, and 3 feet deep, supplied with 40 gallons of water per minute at a temperature of 50 to 60 deg., have a capacity for 3,500 rainbow trout 2 years of age; 1,800 3 years old; 1,000 4 years old, and 900 5 years old. This trough and pond system is typical for rearing any species of brook trout, as well as lake trout and Atlantic and landlocked salmons, for three or four months, which is as long as it is customary to hold young fish intended for distribution. Brood fish may be obtained by selection from the fingerlings intended for distribution, which as they develop are transferred to stock ponds.

As soon as the fry swim up looking for food they are fed several times a day an emulsion of finely ground liver. This diet is continued as the young fish develop, with the difference that the liver is less finely ground and is given less frequently—two or three times a day being sufficient when the fish have attained a length of 2 to 3 inches. The kind of liver used varies at different stations, that of sheep, beeves, and hogs being extensively used, and the relative value of each being in the order named. The food for the larger fish consists of the liver, lungs, and hearts of the animals already mentioned.

At Manchester, Iowa, it has been found advantageous from an economical standpoint to mix the animal food, after it has been ground, with a mush made by cooking wheat middlings or shorts, to which a moderate amount of salt is usually added. After the mush has been thoroughly cooled the animal matter, uncooked, is stirred into it in the following proportions: For fingerlings, 1 part animal matter and 2 parts mush; for adults, 1 part animal matter and 3 parts mush. Twenty gallons of boiling water and 50 pounds of wheat middlings will make about 202 pounds of mush.

The provision of food for domesticated fish is one of the greatest problems the fish culturist encounters, and has been the subject of considerable experimentation. The intensive production of natural food has not received in the United States so much attention as in Europe nor so much as the subject deserves. The American method of raising trout precludes the economic use of natural live food, although unquestionably the edible qualities of the fish might be much improved thereby.

For several years the roe of the branch herring (*Pomolobus pseudoharengus*) has been used at several stations as a substitute for liver in feeding fry and fingerlings. It is purchased from cannery men, who preserve in tins large quantities of it for human consumption, and consequently are able to sell it at a price close to or less than the cost of liver, due allowance being made for the waste in liver and the labor involved in its preparation as a fish food. The herring roe has the advantage of always being on hand in condition ready to feed and is therefore especially desirable for isolated stations. It is not customary to feed young fishes on this food after they are 2 or 3 months old.

At Craig Brook, Me., fly larvæ,[4] used for a number of years in rearing trout and salmon to fingerlings, proved to be a very satisfactory food and the fish attained a more rapid growth than when fed on liver and other dead material. From a financial standpoint it was not as economical as freshly prepared liver or other animal foods, and this, coupled with the objectionable odor attendant on its preparation, had much to do with its discontinuance.

It is possible, however, to utilize animal refuse advantageously for the production of fly larvæ by means of a contrivance in which the material on which flies have deposited their eggs may be suspended over the water. This contrivance consists of a wooden frame, like a box without top or bottom, placed on floats and having an air-tight cover to prevent the escape of foul odors. Within the frame are two trays, the bottoms of which are made of coarse wire-cloth (odds and ends of old hatching trays). Excelsior or straw is placed on the trays, and waste meat or other animal refuse is placed on top of this material. As the larvæ hatch they work through the excelsior, cleaning themselves thereby, and drop into the water. Two small trays are preferable to one of larger size, that the meat may alternately be renewed, thus insuring a more constant supply of larvæ. The noxious animals killed in the protection of fish may advantageously be disposed of in these trays.

Special Devices Applied at Trout Stations.

Study and experience in recent years have revealed abnormal aeration as a condition existing in various water supplies at trout-culture stations, with consequent mortality among the fish. Of the methods used to correct such abnormalities, that devised by the superintendent of the station at White Sulphur Springs, W. Va., Mr. R. K. Robinson, has proved the most efficient. It consists of a series of ordinary milk pans held in a frame, one above another, in numbers to suit conditions, the bottoms of the pans perforated with a nail or other pointed instrument which will leave a ragged edge to each perforation on the underside of the pan.

This apparatus is set up at the head of the trough in such position that the supply pipe empties into the topmost pan, and the water must pass through the series before reaching the trough. By this separation into fine streams the water is thoroughly exposed to the air, this rectifying any abnormality of air content.

At nearly all trout hatcheries it has been customary to place horizontally below the supply pipe at the head of each trough a screen consisting of a light frame, bottomed with wire cloth or perforated metal. This is designed not only to break the force of the stream entering the trough, but to aerate or deaerate the water and at the same time catch foreign substances and animal life—the latter at times being quite objectionable. Such screens, however, have almost invariably caused the water to spatter over the sides of the trough, resulting in constantly wet surroundings. To overcome this objectionable feature a conical perforated screen has been devised by Mr. M. E. Merrill, of the St. Johnsbury, Vt., station. When the screen is in place the current of water falls directly on the apex of the cone, and thus is spread over the entire perforated surface, accomplishing the objects of all other styles of head screens, and avoiding the spattering of water over the sides.

A device for assorting young salmon and trout was introduced in the Bureau's operations by Mr. J. P. Snyder, an employee at one of the stations. It consists of a series of screens by means of which to separate the fingerlings into sizes.

In length the screens are slightly less than the width of the troughs, to facilitate sliding them along. There should be two screens for each size of mesh. In use one screen is carefully inserted at the foot of the trough close to the tail screen, due precaution being taken that no fish are pinched and that none are left between the foot screens and the end of the trough. Midway of the trough a screen should be securely fastened in a vertical position by wedging. After the first screen is in position a similar one is inserted at the head of the trough and then moved along toward the center.

As the two screens are brought closer together the fish between them become frightened, and all that are small enough escape through the mesh of the screens. The distance of the second screen from the first should depend upon the number and size of the fish in the troughs, and also upon the number that escape through the screen. The second screen should also be fastened by wedging. Then the hand of the attendant is moved about among the fish between the screens to guard against any small ones finding a hiding place. In their efforts to escape some of the fish will be hung in the wire cloth, but it will be noticed that every trout which gets its head through the screen can pass or be assisted through without injury. The few which are caught in the mesh should be assisted by grasping the tail and pushing them. It would be well to refrain from feeding for about twenty-four hours before assorting the fish.

By using two or three sets of screens in different troughs at the same time one man can assort many thousands of fish in a day, and the sizes will be much more uniform than when assorted with a scaff net. Wire cloth, six bars to the inch each way, painted with asphaltum varnish, will permit all brook trout under one inch in length to pass through. By varying the mesh of screens brook trout may be assorted into six uniform sizes as follows:

Number of bars to the inch.	Size of fish.
6	All under 1 inch.
5	All between 1 inch and 1½ inches.
4	All between 1½ and 2 inches.
3	All between 2 and 2 3/8 inches.
2 5/16	All between 2 3/8 and 3 inches.
2	All between 3 and 3¾ inches.

The frames of these screens are made of half-inch wooden strips grooved and tongued at the ends. These frames are one-eighth inch less in length than the inside width of the troughs and in height equal the depth of the troughs, being rectangular in form. They are covered on one side with wire cloth held firmly by copper tacks, both the wire cloth and the frames being painted with asphaltum varnish previous to tacking the wire on the frames. This not only helps to preserve the wood and keep the wire from rusting, but smooths the latter so that there are no rough surfaces or projections to injure the fish as they work their way through.

Atlantic Salmon.

Another important branch of fish culture is conducted at the Craig Brook station, near the Penobscot River, not far from Bucksport, Me. While not restricted in its work to this one species of fish, the primary object of this hatchery is the propagation of the Atlantic salmon. The decadence of this important fishery on the North Atlantic coast, due to the ruthless but natural progress of civilization, is too well understood to call for an explanation here. Suffice it to say that to-day the Bureau is maintaining a commercial fishery for the Atlantic salmon on the Penobscot River purely by artificial propagation. It is the only river in the United States where this once abundant salmon is now found in sufficient numbers to support a fishery or to warrant its artificial culture, and here, with the natural conditions so changed, it is with no little difficulty that the extinction of the species is prevented.

The operations at this hatchery, fully described in the Manual of Fish Culture published by the Bureau of Fisheries in 1900, have undergone slight change of method and need not be dwelt upon here. The source of egg supply is the catch of the fishermen's weirs usually during the month of June, the fish being purchased and towed in live cars to the station, where they are transferred to inclosures and there retained until the spawning season in October and November. When ripe they are stripped and the eggs placed upon wire trays, which are stacked in troughs and carefully tended until the early spring, when the eggs hatch. The young fish are distributed for the most part as fry, but a considerable number are reared to the fingerling stage.

POND CULTURE.

Pond culture in the United States is applied only to nest-building fishes, such as the basses, sunfishes, and the common catfish (*Ameiurus nebulosus*). These species do not submit to manipulation for taking and fertilizing their eggs, but fortunately a very large percentage of the eggs are fertilized when the spawning functions are permitted to occur naturally, and the parent fish care for and protect the young until the latter are free swimmers. The cultivation of these fishes, therefore, consists in providing ponds which shall give to the maximum number of breeding fish and their young all the essential conditions of a natural environment, while at the same time protecting them from their enemies and holding them under control.

The Ponds.

Economy in construction usually dictates the shape and area of the ponds, but an independent water supply and drainage to each is desirable. For convenience of the fish culturist the area usually ranges from one-fourth to one acre, although some ponds of larger size are desirable. It was formerly considered essential to have at least one-fourth the area of the breeding pond not exceeding 1 foot in depth, but it has been found that the deepening of the shallower portions to a minimum depth of from 1 foot to 1½ feet has largely increased the productive area.

The presence of aquatic plants in fish ponds is a prime essential. The young of the nest-building fishes do not accept artificial food, and must therefore have their natural diet of minute animal life, the abundance of which is dependent to a large extent upon the character and abundance of plant growth. Plants are also important as oxygenators of the water and afford shelter and shade for the fish. The selection and control of aquatic vegetation, therefore, is a matter to which the fish culturist must give much attention, and experience at the various stations indicates that it offers a direct means by which the output of the ponds may be increased. The subject has not been sufficiently studied, but observations so far made suggest

[4] Atkins, Chas. G.: The live food problem, American Fisheries Society, 1903; also food for young salmonoids, Proceedings Fourth International Fishery Congress, Bulletin Bureau of Fisheries, vol. xxviii, 1908, pp. 839-851.

various practical possibilities of much interest.[5]

The supposed loss of young fish by the voracity of their parents induced the practice of partitioning the ponds in such a manner as to confine the adults in one portion while permitting the young to escape through the partitions to safety. It has been found, however, that the loss from cannibalism is due chiefly to the young fish themselves, and accordingly they are separated from their parents or not, merely as a matter of convenience. The principal precaution against cannibalism is, instead, the provision of an abundant food supply to divert the fish from each other.

Food for the Adult Fishes.

Food for the adult fishes is largely a matter of local conditions and convenience. Chopped fish is extensively used at some stations, and crawfish, so abundant in some localities, when chopped make admirable food for the adult stock. The basses, although not appearing to care for pollywogs as naturally present in the ponds, will devour frog tadpoles voraciously if the latter are seined out and thrown back by the fish culturist, but they absolutely refuse toad pollywogs when similarly served to them. Minnows are a good food, but should not be introduced into the ponds near the spawning season, as they eat not only the small forms of life upon which the fry depend, but often eat the fry as well. Dead minnows thrown into the water one at a time are greedily taken by the adult basses.

Adult bass may also be advantageously fed on strips of beef liver about 2 to 3 inches long and from one-half to one-fourth inch in width or thickness; and prepared food consisting of ground liver or other animal substance mixed with a mush of cooked shorts, corn meal, or middlings has been employed in a rather limited way. It is worthy of note that for this prepared food to be attractive to bass it must ordinarily contain at least two-thirds of the animal substance, whereas prepared food containing only 10 per cent of the animal material is taken with avidity by trout.

It has been quite conclusively demonstrated that one of the principal causes of loss among brood fish is overfeeding, resulting in a fatty degeneration. This loss has been largely overcome by reducing the food supply and at the same time varying the kind of food furnished.

(To be continued.)

[5] Titcomb, J. W., Aquatic plants in pond culture. Bureau of Fisheries Document 643, 1909.

PRINCIPLES OF MECHANICAL FLIGHT.*

SOME FIGURES RELATING TO FLIGHTS OF BIRDS.

NATURAL flight—that is, the flight of birds—can be divided into three classes:

1. Flight by flapping wings.
2. Flight by gliding, with impetus gained during the flapping.
3. Soaring flight, without flapping the wings, often against the wind. The albatross and buzzard can soar for hours at a stretch. In fact, a bird can support itself and move forward in the air for hours continuously, and even rise, without a beat of the wing.

The smaller the creature, the quicker the wing beat. Marey's table giving the various wing beats is as follows:

	Beats per second.
Common fly	330
Bee	190
Wasp	110
Dragon fly	28
Sparrow	13
Wild duck	9
Pigeon	8
Screech owl	5
Buzzard	3

A sparrow, or other bird of similar size, can commence flying from the ground. Larger birds need a run before getting into flight, while soaring birds of the albatross type practically live on the wing, and, for the most part, without the necessity of using muscular energy.

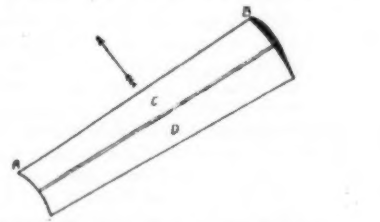


Fig. 1.—Distribution of Lifting Power.

On the other hand, the partridge type of bird employs an enormous amount of energy, traveling in a straight line at high speed, and not making any use of air currents.

A swallow supports only 0.276 pound per square foot of wing surface, whereas the duck's wing has to support 2.280 pounds.

The frigate bird will not touch a solid support for a month, stealing its food from fish hawks. A twenty-pound condor, with 10 pounds of freshly-gored carrion, will serenely float at an altitude of three miles, until it is digested.

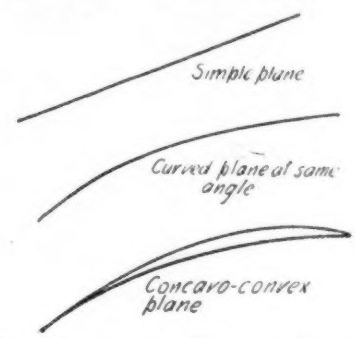
A frigate bird can ascend half a mile at a speed of 100 feet per second without a single wing beat.

The nearest approach to the soaring bird in mechanical flight is the monoplane. The following table will give the lift and drift of an inclined plane with varying tilt:

Angle of Inclination, Degrees.	Normal Pressure.	Lift.	Drift.
2	0.070	0.070	0.0024
4	0.139	0.139	0.0097
6	0.207	0.206	0.0217
8	0.273	0.270	0.038
12	0.398	0.650	0.304
25	0.718	0.650	0.304
35	0.867	0.708	0.498
45	0.945	0.666	0.666

If a perpendicular plane, 500 square feet, travels at 20 miles per hour, the pressure at 1 1/5 pound per square foot would be 520 pounds. But with the plane inclined four degrees to the horizontal the "lift" is 0.139 of 520 pounds, and the "drift" or propeller thrust will be 0.0097 of 520 pounds.

* The Practical Engineer.



Figs. 2, 3, and 4.—The Last the Best Form for Mechanical Flight Purposes.

Wind Table.—The following table will give the approximate in pounds per square foot at various speeds:

Wind per statute mile per hour.	Pressure in pounds per square foot.
2 to 12, average 6	Between 0.01 and 0.05
13 to 23, average 17	Between 0.5 and 1.6
24 to 37, average 30	Between 1.6 and 4.2
38 to 55, average 45	Between 4.2 and 9.2
56 to 75, average 65	Between 9.2 and 17.0

The proportion of the entering edge of the plane to the size of the plane is of the utmost importance. A plane 10 feet square will lift less than a plane 100 feet entering edge, and 1 foot from entering edge to back, although both, of course, contain the same area.

Distribution of Lifting Power.—In connection with mechanical flight, reference should be made to Fig. 1. The entering edge is *A B*. The half of the plane *C* equals the half of the plane *D*, but the lifting power of *C* is greater than *D*. (Arrow shows direction of movement.)

A monoplane 100 feet by 2 feet will lift 2½ pounds per foot at 40 miles per hour, and at a tilt of 1 in 10. The same results follow with a biplane 50 feet by 2 feet. The total lift will be 500 pounds.

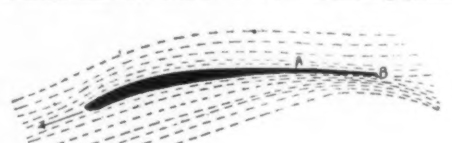


Fig. 5.—Showing the Action of a Concavo-convex Plane on the Air.

If the entering edge is halved in length, and the distance from front to back is doubled, thus retaining the exact area as before, the lifting power is reduced by more than half, the effective area lying all in the front 2-foot section, *C* in Fig. 1.

Fig. 2 shows a simple plane, Fig. 3 a curved plane at the same angle, giving a considerably increased effect, while Fig. 4 shows a concavo-convex plane, the best form for mechanical flight purposes. Fig. 5 is a diagram showing the action of concavo-convex plane on the air. Air pressure at *A* assists propulsive power, the air leaving the plane at *B* with a downward movement.

The use of hardness testing devices on rolled brass is referred to by the Brass World. Brass is rolled in many different "tempers." Usually, when a sample of sheet brass is sent in so that an order to be filled may match it, bending or scratching is resorted to to determine its temper, the result often being only a guess. The hardness testing methods used with steel are to be employed for brass, but the ability to determine the "temper" of a sample of brass is not yet recognized.

A TURBO-ELECTRIC LOCOMOTIVE.

AT the opening meeting of the session of the Glasgow University Engineering Society, the Hon. President, Mr. Hugh Reid, M.Inst.C.E., of the North British Locomotive Company, delivered an address in which he made reference to a turbo-electric locomotive his firm is now building. This new engine is a self-contained electric locomotive, generating, as the Heilmann locomotive was designed to do, its own electricity. The Reid-Ramsay engine carries a boiler, steam-turbine, dynamo, motors, and condensing plant. It is an experimental locomotive, and it is hoped to try it, when completed, on main-line express passenger work, when interesting comparisons should be possible. Its construction has involved lengthy and expensive experimental work. We give below a brief description of this interesting venture, taken from Mr. Reid's remarks as recently reported in the Glasgow Herald. Mr. Reid said:

Steam was generated in a boiler of the ordinary locomotive type, fitted with a superheater, and the coal and water supplies were carried in the side bunkers and side water tanks at both sides of the boiler. The steam from the boiler was led to a turbine of the impulse type, running at a speed of 3,000 revolutions per minute, to which was directly coupled a continuous-current, variable-voltage dynamo or generator. The dynamo supplied electrical energy from 200 to 600 volts to four series-wound traction motors, the armatures of which were on the four main or driving axles of the locomotive. The exhaust steam from the turbine passed into an ejector condenser, and was, together with the circulating condensing water, delivered eventually to the hot well. As the water of condensation was free from oil, it was returned from the hot well direct to the boiler by means of a feed pump. The supply of water carried in the tanks was circulating water for condensation purposes. This condensing water was circulated within practically a closed cycle by means of small centrifugal pumps driven by auxiliary steam turbines placed alongside the main turbine and dynamo. The cycle of the condensing water was from the tanks through the first pumps, then through the condenser, where it became heated in condensing the exhaust steam, and then to the hot well. From the hot well it passed through the second pump to the cooler, situated in front of the locomotive, where the full benefit of the blast of air caused by the movement of the locomotive, aided by a fan, was utilized for cooling the hot circulating water. After passing through the cooler the water was returned to the supply tanks.

In the experimental locomotive the induced draft in the ordinary steam locomotive was replaced by forced draft, provided by means of a small turbine-driven fan. The fan was placed within the cooler so as to deliver hot air to the fire, and at the same time assist the current of air through the cooler. The small switchboard and the instruments required, the controller for grouping the four motors in series—series-parallel and parallel, according to the drawbar pull to be exerted—and the regulator for controlling the voltage in the electrical circuit, and consequently the speed of the train, are all placed together on the driver's platform.

The whole of the foregoing plant was mounted upon a strong under-frame, carried upon two eight-wheeled compound bogies. Each bogie carried two of the four driving motors.

NEW INVESTIGATIONS IN PHYSICS.

INTERESTING STUDIES FROM DIFFERENT SOURCES.

APPARATUS FOR THE MEASUREMENT OF THE ELECTRIC POTENTIAL OF THE AIR.

In order to measure the difference of potential which exists between the surface of the ground and any point in the air above, it is necessary to place at this point an electric equalizer or collector, and connect it with an electrometer. For the measurement of the potentials of points near the ground it has been the custom

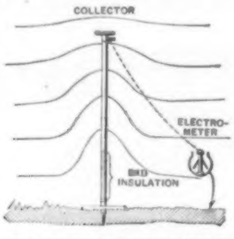


Fig. 1.—SHOWING IMPERFECTION OF INSULATION.

to place the collector upon the end of a pole formed of some insulating substance, such as hard rubber. It is very difficult, however, to maintain good insulation for a long time by this method. This imperfection in the insulation may give rise to considerable error by causing the equipotential surfaces to curve upward, as shown in Fig. 1, so that the potentials which are recorded are too small. For this reason a German station for the study of atmospheric electricity employs metal rods set in good insulators, which are buried in the ground.

Each of these insulators consists of two concentric iron tubes, the space between which is filled with fragments of hard rubber, tightly rammed in. The upper surface of the rubber is corrugated in order to increase

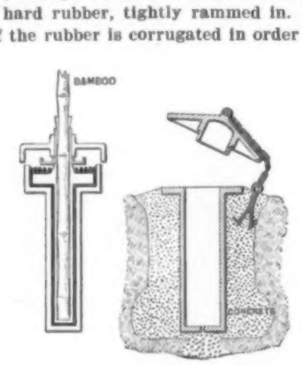
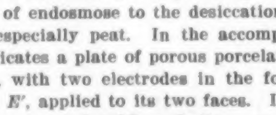


Fig. 2.—INSULATOR SET IN CONCRETE PIT.

the superficial distance between the tubes, and it can be kept dry by means of calcium chloride or metallic sodium. With these insulators, which are set in pits filled with concrete, no difficulty is experienced in keeping poles even 40 feet high perfectly rigid and well insulated.

THE DESICCATING POWER OF ELECTROLYTIC ENDOSMOSE.

Attempts were made a few years ago to apply the phenomena of endosmose to the desiccation of various materials, especially peat. In the accompanying diagram T indicates a plate of porous porcelain saturated with water, with two electrodes in the form of gratings, E and E', applied to its two faces. If these electrodes are connected with a battery or dynamo of suitable electromotive force, the upper surface of the plate is observed to become dry very rapidly, while water exudes from the lower surface. Hence, it appeared reasonable to assume that a moist substance could be desiccated by strewing it upon the plate. It



DESICCATION BY ELECTROLYTIC ENDOSMOSE.

was found by experiment, however, that the amount of desiccation which can be produced in this way is exceedingly small in comparison with the electrical energy consumed. The great expectations which farmers and manufacturers had formed of this process were, therefore, not realized. It was found quite impossible to extract any appreciable quantity of water from vegetable matter, such as potato meal and sliced sugar beets.

Nernst has recently discussed the theory of this process and has also made a series of experiments. His theoretical results fully account for the unsatisfactory outcome of the practical tests of the process. He finds that the energy actually utilized in the desiccation of peat by this method does not exceed one-fifth per cent of the total electric energy employed, even under the most favorable conditions, so that it is impossible by this method to remove water from the interior of vegetable cells. Only the water which is loosely attached to the surface can be removed by endosmose.

OBSERVATIONS ON THE FRACTURE OF GLASS OBJECTS.

Gabelli has published a description of a peculiar series of experiments which might appear to possess

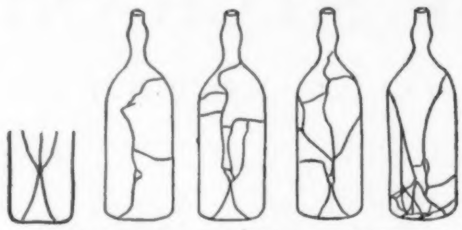


Fig. 1.—BOTTLES BROKEN BY BLOWS FROM OUTSIDE.

little practical interest, but which exhibit a number of remarkable phenomena. He broke bottles and sheets of glass of different kinds, by very different methods, and observed the character of the fracture in each case. The methods of producing the fracture were of three classes: First, the glass is attacked locally from the outside, as when it is struck by a projectile; second, the entire surface of the glass is affected by an external cause, as when a bottle is broken by the freezing of the water contained in it; third, the cause of fracture is internal, as when the glass is broken by unequal heating.

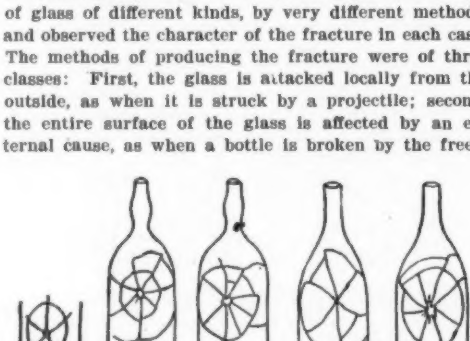


Fig. 2.—BOTTLES BROKEN BY BLOWS FROM INSIDE.

Each of these three methods produces a characteristic fracture. Most of the experiments in which the first method was used were conducted with bottles, and fall into two groups. When the bottle is struck on the outside with a pointed tool, fractures of the

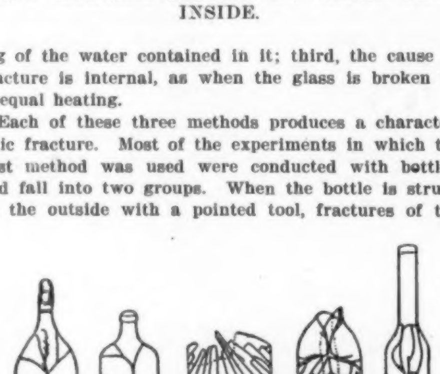


Fig. 3.—BOTTLES BROKEN BY FREEZING OF WATER.

character shown in Fig. 1 are produced. These fractures possess a certain degree of linear symmetry, one line or group of lines proceeding upward and another downward, while the portions of the glass to the right and left of the point of attack remain almost intact. When the bottle is broken by a blow from the inside, by means of a system of levers, the fractures shown in Fig. 2 are produced. Here the cracks radiate from a center and form nearly equal angles with each other, while the center is surrounded at some distance by one or more cracks of nearly elliptical form. In the ex-

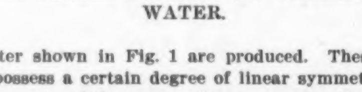


Fig. 4.—GLASS BROKEN BY HEATING ITS EDGE.

periments performed by the second method a bottle was broken by hydraulic pressure or the freezing of water. The results are shown in Fig. 3. This class of fractures is characterized by a branch formation, two groups of branches, directed upward and downward, being connected by a common straight stem. In the third class of experiment, in which the cause of fracture is internal, plane sheets of glass were heated by a flame directed upon the edge or some other point.

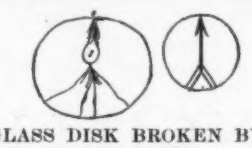
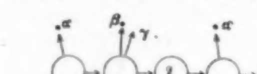


Fig. 5.—GLASS DISK BROKEN BY HEATING ITS CENTER.

When the edge was heated, the heated points were surrounded by curved cracks, as shown in Fig. 4. When the heat was applied to the middle of a disk the fractures shown in Fig. 5 were produced. In this case the pattern bears a general resemblance to an arrow, but it is more or less modified by the distance of the heated point from the edge of the glass.

THE DEVELOPMENT OF RADIUM FROM URANIUM.

The experiments of Soddy make it probable that radium is produced from uranium by the series of transformations indicated in the diagram. Uranium, which has a "half-decay period" of 600 million years, is converted, by a radioactive change, in which par-



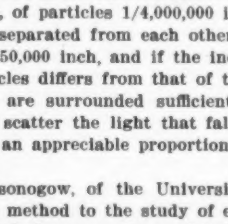
THE DEVELOPMENT OF RADIUM FROM URANIUM.

ticles are emitted, into uranium X, which has a half period of only 22 days. Uranium X emits β and γ rays and is converted into ionium, a product of very great and unknown longevity. Ionium is ultimately transformed into radium, without emitting rays of any kind. Radium itself has a half period of 1,300 years and emits α rays only in its first transformation.

AN ULTRAMICROSCOPIC STUDY OF ELECTROLYSIS.

The ultramicroscope, invented by Siedentopf and Zsigmondy a few years ago, is an ordinary microscope, in which the field is illuminated by a very powerful beam of light, directed perpendicularly to the optical axis. By means of this device it is possible to detect the position and movement, though not the shape, color or structure, of particles 1/4,000,000 inch in diameter, if they are separated from each other by intervals as large as 1/250,000 inch, and if the index of refraction of the particles differs from that of the medium with which they are surrounded sufficiently to cause the particles to scatter the light that falls upon them so widely that an appreciable proportion of it enters the microscope.

Prof. Rossonogow, of the University of Kieff, has applied this method to the study of electrolysis. The application of the current was followed instantly by the appearance, in the liquid, of very numerous bright points which moved toward the cathode with a velocity of the order of magnitude of the computed velocity of the ions of the electrolyte employed, while new bright points continually appeared at the anode. The direction of motion was reversed by reversing the cur-



ELECTROLYTIC IONS REVEALED BY THE ULTRAMICROSCOPE.

rent. The moving particles were deviated by a magnetic field, showing that they carried electric charges.

The appearances presented by different parts of the electrolyte are shown in the accompanying diagrams. The ions were most densely congregated in a thin stratum of the electrolyte, the front of which was from 1/500 to 1/300 inch distant from the opposing face of the cathode. This vacant space is analogous to the dark space of a Geissler tube and, like the latter, persists no matter how greatly the electromotive force is increased. In the electrolysis of distilled water a second vacant space was observed, while copper sulphate solution and some other electrolytes exhibited phenomena which cannot yet be explained.—Prometheus.

KILLING GERMS BY LIGHT.

ULTRA-VIOLET RAYS AND THE STERILIZATION OF LIQUIDS.

BY G. LOUCHEUX.

THE ultra-violet rays which lie beyond the visible part of the spectrum are remarkable for their chemical activity. They also possess great bactericidal power, as has been clearly shown by many researches. Numerous attempts are being made to utilize this

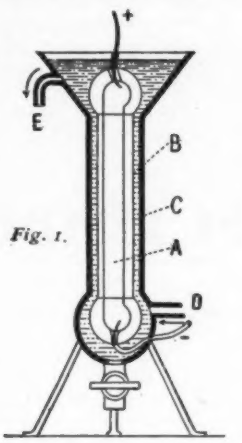


FIG. 1.—BILLON-DAGUERRE STERILIZING LAMP.

power of destroying injurious microbes, and thus a new industrial art is being developed which, it is to be hoped, will render great service to public and private hygiene. The two forms of apparatus which are here described and illustrated, those of Billon-Daguerre and of the Westinghouse Company, have given very interesting and successful results.

For the understanding of what follows, it must be

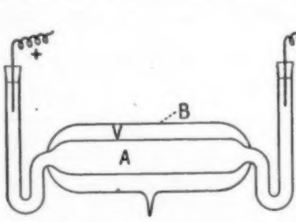


FIG. 2.—BILLON-DAGUERRE IMMERSION LAMP.

borne in mind that ultra-violet rays are readily absorbed by most substances. Very few bodies are transparent to them. They even pass through air with difficulty, but they traverse without appreciable absorption quartz, Iceland spar, pure water and a variety of glass called Uviol, invented recently by Schott of Jena. Both the ultra-violet and the visible rays are distinguished among themselves by their wave-lengths, which stand in an intimate though complex relation to their indices of refraction, or to the relative positions occupied by the different rays after refraction by a prism. The unit of measurement of wave-length is the micron, equal to 1/1,000 millimeter, or 1/25,000 inch. The Angstrom unit, equal to 1/1,000 micron, is also employed.

The Billon-Daguerre Apparatus.—The first appara-

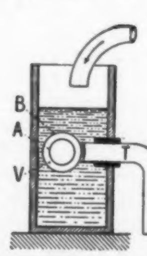


FIG. 3.—OUTLET PIPE.

tus of M. Billon-Daguerre, devised in 1905, is a simple adaptation of the mercury vapor lamp, which is a very prolific source of ultra-violet rays. In this apparatus (Fig. 1), the quartz tube *A*, in which the electric arc is produced, is inclosed in an outer tube *B*, also made of quartz, and by an exterior brass case *C*. The liquid to be sterilized enters through the tube *B*, fills the annular space between the outer quartz tube and the brass case, forming a liquid cylinder 1/25 inch thick, and is discharged at *E*, after having been subjected to the sterilizing action of the radiations during its ascent of about 32 inches. A second device, invented in 1909, is the quartz immersion lamp (Fig. 2). This consists of a quartz cylinder *A*, in which the light is produced, inclosed in a large quartz tube *B*. From the space *V*, between the two tubes, the air is exhausted, down to a pressure of 1/6 inch of mercury. The apparatus is completely immersed in the liquid to be sterilized, which is protected very greatly from the heating

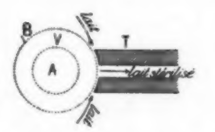


FIG. 4.—OUTLET PIPE FOR MILK.

effect of the lamp by the vacuum *V*. As the layer of liquid which is immediately in contact with the lamp is rendered entirely free from germs, the ideal method of using the apparatus would consist in drawing off this liquid directly. An approximation to this condition has been made by the employment of a system of bent silver tubes *T*, *T′ T″* (Fig. 5), the mouths of which are brought very close to the outer envelope of the lamp *B*, and are so formed as to follow the curve of the lamp as exactly as possible. In this way the sterilized liquid can be drawn off from a point as close to the lamp as is desired. For use with milk, the

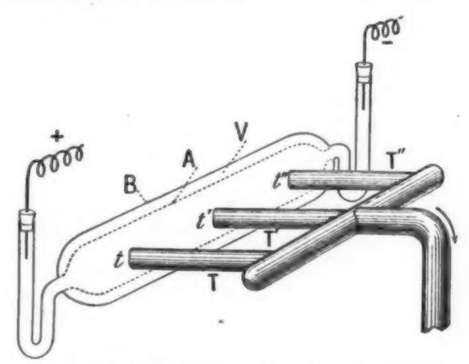


FIG. 5.—IMMERSED LAMP AND OUTLET PIPES.

opacity of which prevents the penetration of the rays to any considerable depth, the tubes employed (Fig. 4) have very thick walls. This construction compels the milk to pass in a very thin stratum between the lamp and the wall of the tube. Other forms of tubes are shown in Fig. 5. By increasing the number of tubes, the quantity of liquid drawn off in a given time can be increased in the same proportion. According to the inventor, this lamp, placed in a glass vessel about 12 inches long and deep and 8 inches wide, is capable of sterilizing 1,000 gallons of wine, beer, grape juice, etc., per hour, with a current of 2 amperes and 110 volts. With clear water the yield can be increased to nearly 3,000 gallons per hour.

In both of these lamps the ultra-violet rays are accompanied by other radiations belonging to the visi-

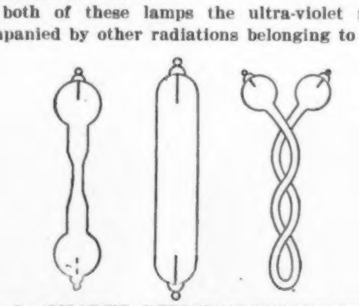


FIG. 6.—QUARTZ GEISSLER TUBES WHICH EMIT HYPER ULTRA-VIOLET RAYS.

ble spectrum, which have comparatively little chemical or sterilizing power. The presence of these rays diminishes the bactericidal efficiency of the lamp and increases the time during which the liquid must be exposed to radiation in order to secure perfect sterilization. The bactericidal efficiency of quartz mercury vapor lamps, for the same expenditure of electrical energy, can be increased in two ways. The useless rays can be eliminated by filtering the radiation through a substance which transmits only the violet and ultra-violet rays. It is also possible to construct a lamp which produces these chemically active rays exclusively, or nearly so. Billon-Daguerre has chosen the latter method. By experimenting with Crookes, Geissler and Moore tubes, containing carbon monoxide,

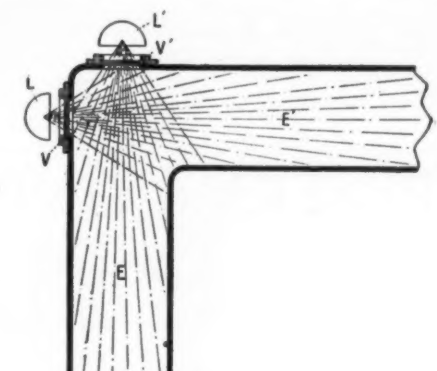


FIG. 7.—STERILIZING WATER IN STREET MAINS.

carbon dioxide, sulphureted hydrogen and sulphurous acid, he has proved, as was done independently and simultaneously by Bumstead and Lyman of Harvard University, that the photo-chemical effects of the radiations emitted by these tubes are about twenty-five times more intense than those obtained with ordinary ultra-violet rays alone. The spectra of these gases show the presence of radiations of exceedingly short wave-lengths (2,600 to 1,000 Angstrom units) lying beyond the ordinary ultra-violet rays. These radiations, to which Billon-Daguerre has given the name

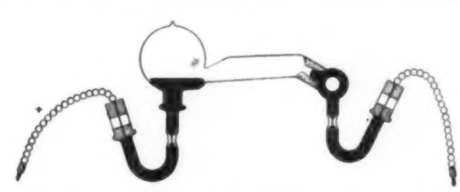


FIG. 8.—QUARTZ WESTINGHOUSE LAMP.

hyper ultra-violet rays, are exceedingly destructive of bacterial life and instantly sterilize liquids upon which they fall. If the mercury vapor lamp in the immersion apparatus is replaced by a Crookes tube, approximately the same quantity of liquid can be sterilized per hour with a reduction of the voltage from 110 to 5 or 6 volts, the current strength and the dimen-

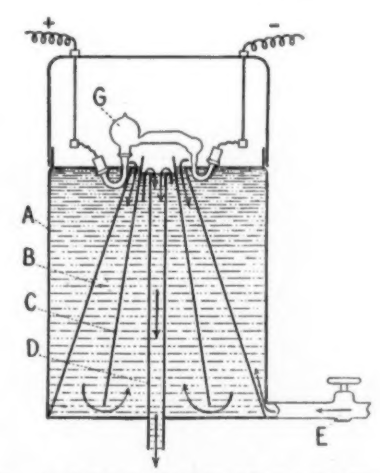


FIG. 9.—WESTINGHOUSE STERILIZING APPARATUS.

sions of the apparatus remaining unchanged. The bactericidal effect is due solely to the radiations themselves and not to any ozone or hydrogen dioxide that may be formed, for the production of an appreciable quantity of these substances requires several hours, but the sterilization is instantaneous. Bordier and Nogier and other physicists have proved that air exposed to the radiations of a quartz mercury vapor lamp acquires an odor resembling that of phosphorus,

which was at first attributed to the production of ozone, but it is impossible to detect the least trace of ozone in this air, and the same odor is produced in nitrogen and other gases which contain no oxygen. In reality the odor is of physiological or subjective origin, and is due to the excitation of the olfactory nerves by the ionized and electrified air. If the gas is passed through a metal tube connected with the ground, and thus deprived of its electrical charge, the odor disappears.

New researches by Courmont, Nogier, and Henri confirm the view that ozone and hydrogen dioxide play no part in the sterilization produced by these lamps, which is due to the direct action of the ultra-violet rays. Water sterilized by this process retains its dissolved air, since it has not been heated. It remains fresh and its flavor is not changed in any way. The small dimensions of the apparatus and the simplicity of its operation allow it to be used in private houses, while its great efficiency and capacity make it suitable for employment in barracks, factories and municipal water works.

For city water service the sterilization may be effected in the water mains (Fig. 7). In order to avoid breakage of the lamps by the pressure and flow of the water they are placed outside the mains and their radiations are transmitted through windows or bull's eyes of quartz.

The Westinghouse Apparatus.—This employs a mercury vapor lamp of the Cooper Hewitt type. The lamp is not immersed in the liquid, but is placed very near its free surface, and the circulation is so contrived that each particle of liquid passes the lamp several times. The apparatus (Fig. 9) is composed of a cylindrical vessel of enameled iron, inside which two cones *B C* and a central tube *D* of the same material are arranged in such a manner that the liquid, entering through the pipe *E*, passes downward through the other cone, upward through the inner cone and finally down through the central tube to the outlet at the bottom of the vessel. In the course of this journey the water passes several times very near the lamp *G* (Fig. 8), which is made entirely of quartz and allows free passage of the ultra-violet rays. The flow of the liquid is regulated by the inlet cock *E*. The apparatus is designed for a maximum yield of about 165 gallons per hour, with a current of 110 volts and 3½ amperes, or a power of 385 watts. Hence the electrical energy used in sterilizing one gallon of water is about 2 1/3 watt-hours.

The water does not remain long enough in the apparatus for the production of ozone or hydrogen dioxide, consequently its flavor is not altered. It is entirely freed of all kinds of bacteria and spores, as has been proven by examinations of water contaminated with various disease germs and then sterilized by this process. The apparatus is very compact and is easily installed.

In conclusion, it should be added that ultra-violet rays exert an injurious action upon the eyes and that they may produce conjunctivitis and other serious troubles. The eyes may be protected by spectacles made of Euphos glass, which is colored with chromium, or more simply and more effectively by ordinary spectacles, coated with a layer of gelatine, stained with ammonium picrate. These precautions should be taken in laboratory work, but they are unnecessary in the employment of the practical apparatus described above, in which the lamps are masked.—La Nature.

PRESERVATIVE TREATMENT OF FARM TIMBERS.*

WHAT EVERY FARMER SHOULD KNOW.

BY C. P. WILLIS.

Concluded from Supplement No. 1808, page 141.

APPLICATION of the Preservative.—It is well known that different woods vary greatly in weight and strength. They also differ considerably in the ease with which they absorb the preservative; so that each species requires a different treatment if best results are to be obtained. In the experiments conducted by the Forest Service and its co-operators the purpose has been to determine the best treatment for various woods. The investigations have also indicated the relative ease of treatment of the different woods. Two methods of treatment were employed. In some cases but one tank was used, and only the butts of the posts were impregnated, though two tanks were used in creosoting most of the woods. In the second method only the butts were immersed in the hot bath, while the whole posts were submerged in the cold bath.

Most species will absorb too much creosote if a very long treatment is given. Therefore, to make the treatments economical, the absorption must be limited to 0.4 gallon per post if only the butt is treated, or 0.6 gallon per post if the top also is impregnated. The best treatment is that which will give, with a reasonable absorption, the deepest possible penetration of the oil into the wood in the shortest time.

Woods which are naturally durable in contact with the ground, such as cedar, locust, white oak, and black walnut, were also included in the experiments. In general, a heavy treatment is required to impregnate their sapwoods, and their heartwoods cannot be successfully treated. Though preservative treatment somewhat prolongs the life of these species, they are not only too expensive to be treated with economy, but even without treatment they are likely to cost more than cheaper and equally satisfactory posts that can be had by creosoting an inferior wood.

In California, posts of different species of eucalyptus were creosoted. A three-hour bath in hot oil was a sufficient treatment for green posts, but the oil penetrated very irregularly. When the posts were inverted after butt treatment, the free oil followed the large ducts in the wood and appeared on the top of the post. A few tests also were made on quaking aspen, boxelder, Douglas spruce, and silver maple. Quaking aspen will probably require a treatment similar to that recommended for cottonwood. The heartwood of Douglas spruce is impenetrable by open-tank treatments, but the sapwood may be easily impregnated. Boxelder and silver maple absorb creosote readily, but the penetration at the ground line is relatively small.

Therefore, whenever a choice of species is possible, only the woods best adapted to preservative treatment should be used. The relative fitness of several of the commoner kinds of wood is shown in Table 1. Yet, because of the different methods used, this table cannot be depended upon to give the exact length of treatment in each case. It is easy, however, to find the best treatment in any particular instance. With well-seasoned material the absorption is indicated by the difference in the weight of sample posts before and after treatment. Pounds may be converted into gallons by dividing by 8.5. The penetration at the ground line may be gaged by boring with an auger or chipping with an ax. Surfaces thus exposed should be well coated with creosote before the post is set. If the first treatment is not satisfactory, better results can be obtained by varying the lengths of the hot and cold baths. If the penetration is insufficient the period of heating should be increased; if the penetration is satisfactory, but too much oil is absorbed, the cold bath should be shortened.

TABLE 1.—*Best results secured in the treatment of various woods.*

[All posts were round, peeled, and seasoned.]

Species.	Absorption per 5-inch post.	Penetration: 2 feet from butt.	Penetration: 2 feet from top.	Single-tank treatment: Butt: Hot oil.	Single-tank treatment: Butt: Cooling oil.	Single-tank treatment: Top.	Double-tank treatment: Hot oil.	Double-tank treatment: Cold oil.
	Gallons.	Inches.	Inches.	Hours.	Hours.		Hours.	Hours.
Ash, white	0.4	0.4		6	12	Dipped a		
Basswood	.6	.1	0.05				1	1
Beech	.6	1.0	.4				1	1
Birch, river	.6	.2	.3				2	1
Butternut	.4	b.5		6	12			
Cottonwood	.4	.6		1	12	Dipped a		
	.6	.1	.1				1½	1
Elm, slippery	.6	b.3	.1				1½	1½
Elm, white	.4	b.4		6	12			
Gum, black	.6	.6	.3				1	1
Gum, cotton (tupelo)	.6	.6	.3				1	1
Gum, sweet (red)	.6	1.0	.3				1	1
Hickory, bitternut	.4	.6		6	12	Dipped a		
Magnolia, sweet (bay)	.6	.4	.2				1	1
Maple, red	.6	1.0	.3				4	1
Maple, sugar	.6	.2	.1				3	3
Oak, pin	.5	c1.0	.5				1	2
Oak, red	.4	b.5	.3				1	1
Pine, loblolly	.5	1.5	1.0				1½	1
Pine, lodgepole	.5	1.2	.6				1½	1
Pine, pitch	.5	1.0	.3				3	1
Pine, scrub	.5	1.0	.4				3	2
Pine, shortleaf	.5	1.0	.3				3	1
Poplar, white	.5	.5	.2				6	10
Sycamore	.6	1.0	.2				1	1
Tulip-tree	.6	.4	.1				2	1
Willow, white	.6	.6	.2				4	1

a Dipped for 5 minutes or more.
b Width of sapwood. Penetration limited by impenetrable heart.
c Requires especially thorough seasoning.

The procedure in treatment may be summarized as follows:

(1) Raise the temperature of the hot bath to 220 deg. F. before putting the posts in the tank. Maintain this temperature throughout the bath. Have sufficient oil in the tank to submerge the butts six inches higher than the ground line when the posts are set.

(2) If only one tank is used, the oil will be absorbed by the posts during the cooling bath, and more should be added to keep them submerged to the proper depth.

(3) If two tanks are used, liquefy the cold bath by heating. The best temperature is from 100 deg. to 120 deg. F. Transfer the posts from the hot to the cold bath as quickly as possible. At least that portion of the post which has been heated should be immersed quickly in the cold bath.

Cost of Treatment.—General cost figures are valueless, but the cost under any specified conditions may be readily ascertained. Apparatus and oil are the two most important items of expense. The charge per post for the apparatus should not exceed one cent when a serviceable outfit is used and its permanency is considered. Labor and fuel charges are usually ignored in fence-post treatments, and hence are omitted in the examples of cost given below. If, however, it is desired to include them, the number of posts treated daily is important. Of course the size of the post affects the cost.

The cost of creosote by the barrel varies widely according to locality. In Eastern States it costs 12 to 15 cents per gallon; on the Pacific coast, 15 to 20 cents; in certain localities in the Rock Mountain region it is as high as 30 cents. In Table 1 the absorption of oil per post is stated for the recommended treatment. To this must be added a certain quantity of oil which evaporates from the hot bath. The amount of creosote which evaporates depends mainly upon the grade used, but 20 per cent of the absorption is accepted as the average. The quantity of oil consumed per post is, therefore, one and one-fifth times the absorption.

Table 2 shows the cost of treatment under certain conditions.

TABLE 2.—*Cost of treatment per post under certain known conditions.*

	Items of cost: Post.	Items of cost: Treating plant.	Items of cost: Creosote absorbed.	Items of cost: Creosote volatilized.	Cost of treated post.
Loblolly pine (Louisiana) or scrub pine (Maryland); entire post impregnated; creosote, at 15 cents per gallon	$0.05	$0.01	$0.06	$0.01	$0.13
Quaking aspen (Maine) or cottonwood (Minnesota), butt impregnated; top dipped; creosote, at 12 cents per gallon	.06	.01	.05	.01	.13

Value of Treatment.—In portions of Maryland locust posts cost 35 cents apiece, and are difficult to obtain even at this price. A pine post, treated in the manner recommended in Table 1, will doubtless equal one of locust in durability, and will cost only half as much. In the prairie region of Minnesota willow posts of sufficient size to last fifteen years cost 25 cents. Creosoted cottonwood posts could be substituted for these, and would be considerably cheaper as well as more durable. In sections of Idaho lodgepole pine posts are extensively used. Table 3 illustrates the annual saving effected by creosoting such posts.

TABLE 3.—*Comparative costs of untreated and treated posts of lodgepole pine in Idaho.*

	Untreated	Treated
Initial cost of post	$0.06	$0.06
Cost of treating post	[illegible]	[illegible]
Estimated cost of setting post	.12	[illegible]
Total cost of set post	[illegible]	[illegible]
Estimated length of service ... years	4	20
Annual cost of post (allowing 6 per cent interest on investment) approximately	[illegible]	[illegible]
Annual saving per post treated		[illegible]

In general, it may be said that any post properly creosoted will last twenty years. To determine the exact length of life under various conditions, posts experimentally treated are being tested in fences, and detail maps on which each post is numbered are made to record the kind of post and its treatment. By means of such maps it is possible to study the durability of the individual posts and the effects of various treatments under different conditions.

PROLONGING THE LIFE OF SHINGLES.

Wood used on the farm in various forms other than post material may often be advantageously preserved from decay by chemical treatment. The results obtained assuredly justify the cost of treating all timbers used in foundations, sills, beams, and planking, as well as the lower portions of board fences, and the

* Reprinted from a Farmer's Bulletin, published by the U. S. Department of Agriculture.

lumber used near the ground in sheds and barns. The treatment of these is very similar to that given posts. Shingles, however, form an important special class of material.

With the grades of shingles obtainable nowadays exposure to rain and sun commonly results in warping or curling. Water absorbed during a storm subsequently evaporates rapidly from the upper surface and rather slowly from the lower surface. Consequently, the upper part of the shingle shrinks more than does the under, and curling or warping results. The importance of excluding moisture is obvious. In addition to this, it is advisable to employ an antiseptic to retard decay. The best preservative, it follows, must possess such qualities as will operate in both these ways to prolong the life of the shingles.

The necessity of applying preservatives only when the wood is thoroughly dry may again be emphasized.

NON-ANTISEPTIC PRESERVATIVES.

The application of paint is the preservative measure most commonly used with shingles. The method of applying it is of paramount importance. Dipping the shingles individually is the only satisfactory procedure. When a roof is painted ridges of paint are formed at the bases of the shingles, owing to the irregularities of the surface over which the brush passes. These cause the water to permeate the crevices between the shingles and frequently hasten decay.

ANTISEPTIC PRESERVATIVES.

The best antiseptics for shingle treatment are creosote and other derivatives of coal tar. Painting the roof with these oils is a rather satisfactory method of treatment, since the coal-tar derivatives penetrate the shingles better than ordinary paint and do not leave ridges below the base of the shingles. At least two coats should be applied. Dipping the individual shingles gives good results. The best results are, however, obtained by heating and cooling the wood in the preservative, as described for the treatment of fence posts. Sap loblolly pine shingles may be thoroughly impregnated by means of the open-tank process. This method is the best even for woods which resist the penetration of the oil; for example, white cedar. Its advantages are twofold—the shingles can be treated in bundle form, and, with proper treatment, the surface of the wood will be free from surplus oil.

The open-tank process has already been explained. The apparatus used for posts may be employed, or if shingles exclusively are to be treated the form of the outfit may be modified. The simplest apparatus is a single tank large enough to hold a bundle of shingles. If a large capacity is desired, the depth rather than the width should be increased, for, in order to minimize the loss from volatilization, the oil surface exposed to the air should be kept as small as possible. The best treatment for various kinds of shingles has not yet been determined. The proper length of treatment may, however, be readily decided in any particular instance by weighing the shingles before and after treatment. An absorption of 12 or 13 pounds per bundle, or six gallons per thousand shingles, is advisable. The cost of treatment per thousand shingles should range from $1.25 to $1.50. In order that the deepest penetration compatible with this absorption may be secured, the heating should be relatively long.

Creosoted shingles possess certain objectionable qualities, though none which prohibit their use. Among these may be mentioned their strong odor and their contamination of cistern water. Further, since the shingle nails become covered with creosote and cannot be held in the workman's mouth, it is said to be more difficult to lay these shingles. The odor, however, disappears in the course of a few weeks—two weeks in one case observed; the contamination of the cistern water is also of short duration—in one instance the water was tasteless after three days of rain; and, in any case, the water from a newly creosoted roof can be diverted from the cistern for a week or so, or until there is no danger of making the water taste, and the use of a shingle-nailing machine obviates the difficulty in laying the shingles. All these objections are removed if the shingles are seasoned for a few weeks between treating and laying.

It is impossible to paint creosoted shingles satisfactorily; hence, if the brownish shade of the creosote is deemed undesirable, it is necessary to stain the shingles during the preservative treatment. Of the common colors green pigment is expensive and red and brown are cheaper. Further, it is necessary to use a comparatively large quantity of green to obtain a satisfactorily colored creosote, while a relatively small amount of red or brown pigment suffices. For these reasons it is not feasible to stain shingles green by the open-tank method of creosoting, and brush treatment or dipping must be resorted to. The latter two methods may also be used with a variety of patented stains containing creosote.

To obtain a red or a reddish-brown creosote 8 to 12 ounces of "color ground in oil," mixed with an equal bulk of linseed oil, should be used for each gallon of preservative.

CONCLUSION.

In many localities the need for the preservative treatment of farm timbers is imperative. Throughout wide areas the advisability of using creosoted posts is indisputable. In spite of these facts it is often difficult for a farmer efficiently to treat his own material with preservatives. This, however, does not indicate that the work should be neglected. Rather it points to some different means of securing the desired result. There are two practical methods of doing this. One is for some individual to undertake the work for the neighborhood.

A small wood-preserving plant could be profitably operated in connection with a threshing outfit, a feed mill, or sawmill. The other plan is for several farmers to co-operate in establishing and operating the plant. As an indication of the success which should attend such an undertaking the co-operative creameries of various sections of the country may be cited. The means, then, may vary, but it cannot be too strongly emphasized that every agricultural district should possess the facilities for increasing, by preservative treatment, the durability of farm timbers locally used.

A NEW METHOD OF IDENTIFYING PERSONS.

THE VEINS ON THE BACK OF THE HAND.

BY PROF. CIPRIAN KOLB AND PROF. LEO GRESZ.

The often ludicrous verbal descriptions which the police formerly employed for the identification of persons were in time largely superseded by photographs of the head and face, taken from the front and both sides. But this method was not very satisfactory, and the search for a more reliable means of identification led to the invention of the Bertillon system of measurement, in which the individual characteristics employed in the old methods are supplemented by the measurements of parts of the body, including the length and width of the head, left forearm, small and middle fingers, ears and feet. Subsequently, Galton devised his dactyloscopic method, based on the curves, due to corrugations of the skin, which are observed on the finger tips.

A method quite distinct from any of these has been developed by Prof. Tamassia, of the University of Padua. It is based upon a hitherto neglected personal peculiarity, the pattern of the veins in the back of the hand. A superficial observer would assume this pattern to be essentially the same in all persons, or at least in all members of the same family, and both Lusanna and Capon assert, in their writings, that it is inherited from father to son. Tamassia finds, on the contrary, that the arrangement of the veins in the back of the hand is so characteristic of the individual that it is not the same in any two persons, and therefore constitutes the best known means of identification. He supports this assertion by the results of Capon's own observations. Capon found only 12 cases of resemblance among 72 vein patterns, and even in these cases the resemblance was less striking, even on superficial observation, than the divergence. Capon's drawings of the vein patterns of a child and its parents are reproduced in Fig. 1. Comparing the three left hands (the lower figures) we see that the veins of the child resemble the mother's, but are entirely different from those of the father. Of the vein patterns of the right hand (the upper figures) no two resemble each other. These drawings show, also, that the vein patterns of the right and left hands of the same person may be strikingly different.

It happens not infrequently that the vein patterns of the right hands of two persons are almost identical, but this close resemblance is never observed in both hands of two persons. Hence the vein patterns of the two hands assist each other in the identification. It is this almost incredible diversity in the arrangement of the veins of the back of the hands that gives Tamassia's method its great value in the work of the police.

Tamassia recognizes six classes of vein patterns of

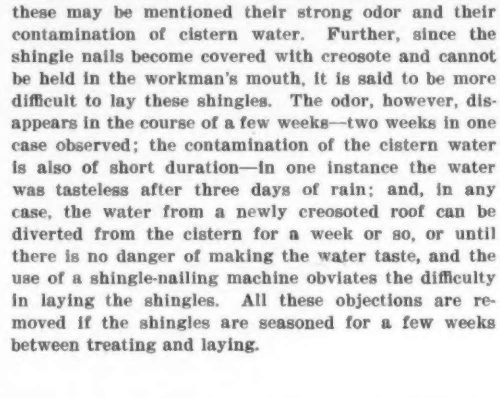
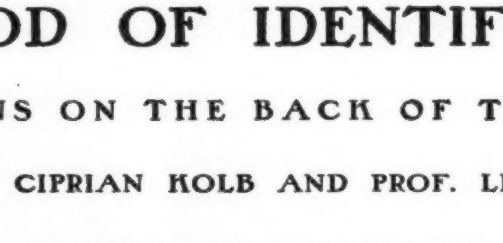


Fig. 1.—Vein Patterns of a Child and Its Parents.



Right hand. Left hand.

Figs. 2 and 3.—Veins of the Right and Left Hands of the Same Person.

the back of the hand. In the first group, one large vein follows a more or less curved or serpentine course, sections of which may be straight, and only a few branch veins are visible.

In the second group, the pattern suggests a tree or shrub. Three or four large veins diverge from the wrist toward the fingers, where each forms one or more branches. The course of these principal veins is usually undulating and crossed by small secondary veins.

In the third group, the pattern includes one large vein and several smaller veins, which form an irregular net, with quadrangular, heart-shaped or oval meshes.

In the fourth group, two large veins, which may or may not be crossed by secondary veins, form a V with its base at the wrist.

In the fifth group, the large veins form an erect and an inverted V, the points of which are connected by a short, straight, and very prominent vein.

The sixth group includes patterns in which the characteristics of the other five groups are combined, often with great complexity.

In the identification of persons by Tamassia's method, it is essential to employ very clear and accurate photographs or drawings. In order to obtain sharp photographs of the vein pattern of the back of the hand, the arm must be left pendent, and slightly bent, during a few minutes. If, in addition, the wrist is bandaged and the veins are marked with a dark pigment the veins will show very conspicuously in the photograph (Figs. 2 and 3).

Hence Tamassia's process presents no great difficulties and its simplicity is one of its special advantages. The arrangement and general appearance of the veins of the back of the hand undergo no change with increasing age and they cannot be altered purposely without inflicting serious mutilation.—Umschau.

Disagreeable tastes and odors in the water supply from the high-service reservoir at Lowell, Mass., during the winter of 1909, were due, it is thought, to algæ which had remained in the basin since the previous summer. To remedy the trouble, as much of the old water as possible was first drawn out and a thin coating of ice over the surface was broken by rowing a boat through it several times. This was done, according to the last annual report of Mr. Robert J. Thomas, the superintendent, to expose the water to the action of the air. In eight days the reservoir was filled with fresh water to its regular depth. No further complaint is said to have been made regarding the supply.

ENGINEERING NOTES.

The possible danger incurred by firemen from directing the stream of water from their hose upon wires which carry electric currents of high voltage, has been long discussed, but the question has not yet been definitely settled. Two curious accidents of similar nature have recently been reported. Both occurred to men working on an electric railway, supplied with current by a third rail. The first man was washing a portion of the track with water contained in an iron bucket. Having finished his task, he carelessly threw the water upon the roadway. The falling water struck the third rail, so that the electric circuit was completed by the water, the iron bucket, the man's body, the earth, and the track. The workman received a severe shock, although it does not appear that he was seriously injured. The second accident was of similar character, but the water was of physiological origin, and no bucket was used.

The Mines Branch of the Department of the Interior of the Dominion of Canada government has established a plant for the manufacture of peat into fuel, at Alfred, Ont., about 45 miles from Ottawa. The plant was built by the government to demonstrate the possibilities of the peat bogs, with which Canada abounds. It commenced operations on May 18th, and is now running continuously. The peat deposits at Alfred consist of about 300 acres, having an average depth of about 10 feet. The plant consists of a long peat-storage shed, two small frame houses, a blacksmith shop and large peat machine. The latter apparatus was imported from Sweden, where there are several hundred such equipments in operation. A long trench, 19 feet wide and 8 feet deep, is cut in the peat, in which the peat machine is placed. A carrier conveys the peat as it is dug from the trench to a hopper. On a 600-foot circular track in the middle of the bogs are 8 peat carriers, each of which holds 0.7 ton of peat. As each car passes the machine, the ground peat is dropped from the hopper into the machine. A 34 horse-power engine, which itself burns about 4 tons of peat fuel per day, furnishes motive power for both hopper and cable cars. The peat in the carriers is then conveyed to a field press, which spreads the peat upon the ground in long parallel rows, and it is then shaped into bricks, which are allowed to dry in the sun and air for three or four weeks, when they are stored in the peat shed ready for transportation. The cost of producing peat is said to be $1.75 to $1.80 per ton. One and eight tenths tons of peat equal one ton of anthracite. A peat-using plant for the production of producer gas has been established in Ottawa and receives its fuel from the peat manufacturing plant at Alfred.

ELECTRICAL NOTES.

The electrical equipment of the new submarines of the French navy is most remarkable. The "Mariotte," "Archimède," and "Amiral-Bourgois" have displacements of about 800 tons, and contain over 2,000 horsepower of machinery; they possess twin screws, each shaft carrying one electric and one explosion motor. In the "Mariotte" the battery is in two halves, coupled in series or parallel, and low speeds are obtained by armature resistance. In the "Archimède," equipped on the Bréguet system, each armature is double wound, with two commutators, and advantages are claimed for this arrangement, especially as regards recharging the battery.

The New York, New Haven & Hartford Railway has recently put into operation the first regular multiple-unit train service between Port Chester and New York. The present equipment consists of four motor cars and six trailer cars. The car bodies are 70 feet long, and each has a seating capacity for seventy-six people. No wood is used in the construction. Each motor car weighs 173,400 pounds complete, and is intended to haul two trailers, each of which weighs 99,000 pounds. All cars are provided with quick-acting automatic air brakes. The cars operate on 11,000 volts alternating current, overhead, and 600 volts direct-current third rail. The electrical equipment of each car consists of four six-pole, 150 horse-power, single-phase series motors, which are geared to spring-supported quills. The quills are connected to the driving wheels in the same way as are the quills on the New Haven gearless locomotive. The motors are connected four in series or two in series and two in parallel when operating with 600 volts direct-current. On alternating current they are permanently connected two in series and two in parallel. The multiple-unit system is used, and a complete motorman's equipment is placed at both ends of every car, trailers as well as motor cars, so that the train can be operated with trailer cars in front if so desired.

The Allgemeine Elektricitaets Gesellschaft has introduced some electric plowing sets. These are on the one-engine system, and are built in sizes of 38 to 72 horse-power. The complete set comprises: A motor truck, driving rope, anchor vehicle, automatically moving rope supports, plow, electric cable, and cable car. The electric motor of the truck can either be coupled to the drum which drives the rope, or to the rear wheels of the vehicle. A device is provided for automatically stopping the motor when the tension in the rope exceeds a definite value. The anchor vehicle has a pulley over which the rope passes. When the plow moves back to the motor truck this pulley is relieved of its load, and by its rotation feeds the anchor vehicle forward the necessary distance for the next furrow. Current is supplied to the motor through a special armored flexible rubber-covered cable of 300 to 1,000 meters length. This in the case of the shorter lengths is carried on an outrigger at the rear of the truck, longer lengths being carried in the cable car. The land plowed per day for small plows is 10 to 20 acres, and for larger plows 24 to 35 acres, according to the depth and the condition of the soil. The consumption of current in plowing 45 acres with furrows 8¾ inches deep is 12 kilowatt-hours; 38.5 acres with furrows 10¾ inches deep, 14.5 kilowatt-hours, and 34 acres with furrows 14½ inches deep, 21 kilowatt-hours.

SCIENCE NOTES.

"A European Crinoid" is the title of Proceedings Paper No. 1749. It is written by Mr. Austin H. Clark, the Assistant Curator in the Division of Marine Invertebrates, U. S. National Museum, and describes a new species of Antedon which has been found in the Adriatic Sea at Trieste. It has been given the specific name of *adriatica*, and the type is in the collection of the U. S. National Museum.

A. Lafay in the Comptes Rendus states that when a current of air impinges upon a polished cylinder, a region on the surface thereof will be found, somewhat in advance of the transverse diameter, at which the pressure of the air upon the surface is equal to that of the surrounding atmosphere; the pressure in front of this region being in excess, and that in the rear in defect, of the general atmospheric pressure. Over the region in question the rate of flow of air current is greater than its mean velocity. The low pressure to the rear of this region is therefore the result of expansion (ejector action), and may be reduced by roughening the surface of the cylinder in this region of high velocity. In a horizontal air current a cylinder having part of its surface suitably roughened with granulated cork is subject to a vertical thrust. It is suggested that propeller blades may be improved by an application of this principle.

The dark lines which appear in a continuous spectrum, if a beam of light traverses an absorbing flame, are divided and polarized under the influence of magnetic forces in exactly the same way as emission lines. This inverse effect has become of considerable importance since the discovery of Hale that sun-spots are the centers of intense magnetic fields, and that the dark lines in the absorption spectra of sun-spots exhibit the characteristic phenomena of magnetic separation. Teeman and Winauer have made an investigation of the separation of the absorption sodium lines $D_1 D_2$ under various types of magnetic field, these lines exhibiting changes of very similar type to those observed in sun-spot spectra. If the observations are made perpendicular to the field, we see in the continuous spectrum four dark components in the case of D_1, and six dark components in the case of D_2. Their relative visibility is to some extent dependent on the vapor density of the absorbing medium. They may be made to appear sharper and blacker by interposing a quarter-wave plate and a nicol into the path of the beam.

Many researches, some theoretical, some experimental, have been undertaken with regard to the sensitiveness of the eye for the different colors of the spectrum, but little is known as to the effect on the eye of a single color of varying intensity or of the total light radiation of a beam. In the Phys. Zeitschr. R. von Koch discusses the problem in the following fashion: If a white surface receives an equal quantity of light energy per second per unit area, the light being composed of different radiations, how great is in each case the photometric brightness of the surface? Bolometric and photometric measurements were made at a distance of 70 centimeters from several different types of lamp, and it was found that for a carbon filament lamp the light intensity for different temperatures is proportional to the 3.7th power of the current through the lamp. So the sensation of light which the eye receives from a surface which is illuminated by an incandescent lamp varies according to the 1.85th power of the quantity of energy per second given out by the surface if the temperature of the filament of the lamp is altered.

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